FINAL FEASIBILITY STUDY FOR THE MARSH CRUST AND GROUNDWATER AT THE FLEET INDUSTRIAL SUPPLY CENTER OAKLAND ALAMEDA FACILITY/ALAMEDA ANNEX AND FEASIBILITY STUDY FOR THE MARSH CRUST AND FORMER SUBTIDAL AREA AT ALAMEDA POINT

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FLEET AND INDUSTRIAL SUPPLY CENTER
OAKLAND, ALAMEDA FACILITY/ALAMEDA ANNEX
AND ALAMEDA POINT
ALAMEDA, CALIFORNIA

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ACRONYMS AND ABBREVIATIONS

$\mu g/m^3$	Microgram per cubic meter
Ac	Acres
Airdrome	San Francisco Bay Airdrome
Alameda Facility/ Alameda Annex	Fleet and Industrial Supply Center Oakland, Alameda Facility/Alameda Annex
AOC	Area of concern
ARAR	Applicable or relevant and appropriate requirement
Army	U.S. Department of the Army
BAAQMD	Bay Area Air Quality Management District
BACT	Best available control technologies
bgs	Below ground surface
BRAC	Base Realignment and Closure Act
CalEPA	California Environmental Protection Agency
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFG	California Fish and Game
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
COPC	Chemicals of potential concern
CTO	Contract task order
DoD	Department of Defense
DTSC	California Environmental Protection Agency, Department of Toxic Substances Control
EBMUD	East Bay Municipal Utility District
EFA WEST	Naval Facilities Engineering Command, Engineering Field Activity West
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
FISCO	Fleet and Industrial Supply Center Oakland
FR	Federal Register
FS	Feasibility study
ft^2	Square feet
ft^3	Cubic feet
FWBZ	First water-bearing zone
GAC	Granular activated carbon
GRA	General response action
HHRA	Human health risk assessment
HI	Hazard index
H&S	Health and safety

ACRONYMS AND ABBREVIATIONS (Continued)

IR	Installation Restoration
IT	International Technology Corporation
mg/L	Milligrams per liter
MLLW	Mean lower low water
NAS	Naval Air Station
NAVFAC	Western Division Naval Facilities Engineering Command
Navy	U.S. Department of the Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NSC	Naval Supply Center
O&M	Operation and maintenance
OU	Operable unit
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
POTW	Publicly owned treatment works
PRC	PRC Environmental Management, Inc.
RAO	Remedial action objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial investigation
ROD	Record of decision
RWQCB	California Regional Water Quality Control Board, San Francisco Bay Region
Sanborn	Sanborn-Ferris Map Company
SARA	Superfund Amendments and Reauthorization Act
SFBCDC	San Francisco Bay Conservation and Development Commission
SVOC	Semivolatile organic compound
SWMU	Solid waste management unit
SWRCB	State Water Resources Control Board
TtEMI	Tetra Tech EM Inc.
TDS	Total dissolved solids
TPH	Total petroleum hydrocarbons
USC	U.S. Code
UST	Underground storage tank
VOC	Volatile organic compound
yd^3	Cubic yard

EXECUTIVE SUMMARY

The U.S. Department of the Navy (Navy) has prepared this focused feasibility study (FS) report in accordance with Title 40 of the Code of Federal Regulations Part 300, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (U.S. Environmental Protection Agency [EPA] 1990a) and the Guidance for Conducting Remedial Investigations and Feasibility Studies under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (EPA 1988). This FS addresses base-wide groundwater and a thin subsurface layer of historical sediment known as the "marsh crust" at the Fleet Industrial Supply Center Oakland Alameda Facility/Alameda Annex (Alameda Facility/Alameda Annex), and contamination associated with the former subtidal area and marsh crust at Alameda Point (formerly Naval Air Station [NAS] Alameda).

Background for Alameda Facility/Alameda Annex and Alameda Point

From the late 1800s until the 1920s, two gas plants and an oil refinery were located near the present locations of Alameda Facility/Alameda Annex and Alameda Point. These facilities are believed to have discharged petroleum products and wastes and, possibly, CERCLA hazardous substances to adjacent marshlands during their operation. The discharges were probably rich in semivolatile organic compounds (SVOC), including polynuclear aromatic hydrocarbons (PAH). The waste migrated over much of the surface of the surrounding marsh and was deposited on the marsh surface through tidal actions, leaving a layer of contaminated sediment under the 143-acre area that is now Alameda Facility/Alameda Annex and the eastern portion of the 2,675-acre area that is now Alameda Point. This layer is known as the marsh crust. Further, to the west, at Alameda Point, the waste was deposited on tidal flats, now known as the former subtidal area. Fill material, which was dredged from the Oakland Inner Harbor and surrounding San Francisco Bay sediment, was placed on these areas from as early as 1887 to as late as 1975, encapsulating the former subtidal area and marsh crust.

Alameda Facility/Alameda Annex was initially used as a commercial airport in the 1920s and 1930s and was later obtained consecutively by the University of California and the Navy. The Navy obtained the southern portion of the facility (Alameda Annex) in 1946 and the northern portion (Alameda Facility) in 1966. The history of the area around Alameda Facility/Alameda Annex is discussed in detail in the remedial investigation (RI) report (PRC Environmental Management, Inc. [PRC] 1996a).

Alameda Point is located on the western end of Alameda Island, adjacent to Alameda Facility/Alameda Annex. Most of the land at Alameda Point was created by filling existing tidelands, marshlands, and sloughs. The western tip of Alameda Island (prior to the construction of Alameda Point) was farmed and later used for railroad yards and rights-of-way for Southern Pacific, Central Pacific, and small, local railroads. The U.S. Department of the Army (Army) acquired the western tip of Alameda Island from the City of Alameda in 1930. In 1936, the Navy acquired title to the land from the Army and began building NAS Alameda in response to the military buildup in Europe before World War II. The history of Alameda Point and the surrounding area is provided in the "Comprehensive Guide to the Environmental Baseline Survey" by International Technology Corporation (IT) (IT 1998b).

Eight Installation Restoration (IR) sites have been identified at Alameda Facility/Alameda Annex. Previous environmental investigations at these sites include a site investigation in 1987, a preliminary assessment in 1988, and an RI from 1992 through 1994, culminating in a final RI report in 1996 (PRC 1996a). Groundwater samples collected from the shallow aquifer were analyzed for metals, pesticides, polychlorinated biphenyls (PCB), SVOCs, volatile organic compounds (VOC), total petroleum hydrocarbons (TPH), and total dissolved solids (TDS). Analytical sampling results from groundwater monitoring indicate that organic and inorganic compounds are present in shallow groundwater underlying the Alameda Facility/Alameda Annex. The source of contamination in groundwater is unknown. Organic and inorganic compounds were detected in groundwater throughout IR sites 2 (IR02) and IR03. Isolated contaminant plumes were also detected at the IR04, IR05, and IR06. Groundwater contamination was also detected at IR07. Soil samples were also collected during the RI from the marsh crust in and around IR02. The marsh crust was identified in most boreholes based on lithographic boring analysis and chemical samples from IR02. Soil samples collected from IR02 were analyzed for metals, pesticides, and PCBs, SVOCs, TPH, and VOCs. As a result, marsh crust is believed to exist and is assumed to be a discontinuous layer throughout the facility with PAH concentrations similar to those measured in the samples collected in and around IR02. The source of contamination in marsh crust is believed to be attributable to discharges of petroleum products and possibly CERCLA hazardous substances. For purposes of this FS releases of CERCLA hazardous substances are assumed to have contributed at least partially to marsh crust and groundwater contamination. Further investigation of the contamination in the former subtidal area and marsh crust and the groundwater is not likely to provide significantly better information regarding the exact location of the contamination or its original source. Some floating petroleum product on the groundwater near IR04 and IR06 is believed to be a non-CERCLA release. This contamination is being addressed under a separate non-CERCLA cleanup action, which is being overseen by the California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB).

Several phases of investigation have been conducted at Alameda Point for soil, sediment, and groundwater. Because of the large number of investigations and IR sites, a basewide RI report has not been prepared for Alameda Point. Instead, sites of suspected contamination were organized into four operable units (OU), with OU-1, OU-2, and OU-3 overlaying the former subtidal area and marsh crust. The former subtidal area and marsh crust were determined by reviewing soil, monitoring well, and geotechnical boring logs and by examining soil analytical data throughout Alameda Point. Data from 133 boreholes extending to depths below the artificial fill-Bay Mud interface were used to define the lateral extent and chemical characteristics of the former subtidal area and the marsh crust. The extent of the subtidal area is defined by a line of equal elevation corresponding to negative 1 foot mean lower low water. The former subtidal area and tidal marshland areas compose approximately the eastern third of Alameda Point. The source of the contamination in the subtidal area and marsh crust within Alameda Point is believed to be attributable to petroleum products and CERCLA hazardous substances releases.

Human Health and Ecological Risk Assessment at Alameda Facility/Alameda Annex

A human health risk assessment (HHRA) was conducted at Alameda Facility/Alameda Annex as part of the final RI report for the site consistent with EPA's guidelines. The HHRA found that there is currently no exposure pathway to humans from PAHs in the marsh crust because of its depth. The marsh crust is present at an average depth of 15.3 feet below ground surface (bgs), well below likely construction depths. The Navy has concluded, however, that although currently no complete exposure pathway is present to the subtidal area and marsh crust contamination at Alameda Facility/Alameda Annex, unacceptable risk is possible if the soil were brought to the surface where it could remain as a source of exposure and could pose an unacceptable risk to human health and the environment.

As part of the original HHRA conducted during the RI at Alameda Facility/Alameda Annex, the risk due to the shallow groundwater was also evaluated. The HHRA concluded that because shallow groundwater has limited beneficial use, no complete exposure pathway exists for human consumption or other beneficial uses of groundwater. Therefore, the HHRA evaluated only risks to site workers and future industrial and residential inhabitants from inhalation of volatilized VOCs. The HHRA concluded that groundwater does not present an excess lifetime cancer risk greater than 1.0E-06 or a hazard index greater than 1.0 under any pathway for either industrial or residential scenarios.

Since completion of the HHRA however, it has been determined that although currently no complete exposure pathway is present to the groundwater contamination, unacceptable risk is possible if accidental ingestion by humans were to occur for an extended period or if ingestion were to result from well construction inconsistent with current construction regulations.

A qualitative ecological risk assessment (ERA) conducted during the RI concluded that no endangered species are present at the Alameda Facility/Alameda Annex. Habitat is limited and the chance of exposure to terrestrial birds and mammals is remote. A quantitative ERA (Tetra Tech Em Inc. [TtEMI] 1998a) was conducted to evaluate whether ecological impacts exist to receptors living in the Oakland Inner Harbor or other surface water bodies from discharges to sediment in the Oakland Inner Harbor from the Alameda Facility/Alameda Annex storm water system. Sediment chemical concentrations at the discharge of Outfall 1 (the main storm drain discharge) were found to be generally within the range of Oakland Inner Harbor sediment chemical concentrations. Sediment bioassays found relatively low toxicity of Outfall 1 sediment and porewater, indicating low bioavailability of contaminants and no ecological effects.

After completion of the RI, additional pathways for human exposure to site groundwater contaminants became evident. California Environmental Protection Agency, Department of Toxic Substances Control (DTSC) and EPA identified the need to evaluate (1) the potential exposure of humans to groundwater through uses other than consumption (such as washing cars, irrigation, and landscaping) and (2) the potential exposure of children and adult workers at a new school proposed for the western part of Site IR02 to indoor air that could be contaminated with VOCs that may volatilize from the contaminated groundwater at the site. To accomplish these objectives, a new HHRA was performed by Newfields Inc. (2000).

After completion of the new HHRA (Newfields 2000), it was found that in both cases, the resulting hazard indices (HI) calculated were below 1 and the cancer risks were either less than, or within the risk management range of, 1.0E-06 to 1.0E-04. The scenarios that had cancer risks within the risk management range for IR02 were landscape worker (8.0E-05), car wash worker (1.0E-05), and school site worker (4.0E-06) and for IR04/06 were landscape worker (1.0E-06) and car wash worker (2.0E-06).

Since the HIs and cancer risks calculated in the Newfields Inc. HHRA were either within or below the risk management range, it was concluded that "there is no scientific basis for restricting either the potential nonpotable beneficial uses of the groundwater at the site or the proposal for placement of a school near the site as an acceptable land-use option" (Newfields Inc. 2000).

Human Health and Ecological Risk Assessments at Alameda Point

At Alameda Point, HHRAs were conducted for soil at OU-1, OU-2 (pending), and OU-3. The HHRAs determined that SVOCs associated with the surface of the former subtidal area and marsh crust do not currently pose an unacceptable risk to current and future resident, because exposure pathways to contaminants in the former subtidal area and marsh crust are incomplete because of the depth at which they occur. However, because the former subtidal area and marsh crust are present from 4 to 10 feet bgs, workers could be exposed to possible PAH contamination during construction of building foundations and utility work (2 to 10 feet bgs). Nevertheless, the Alameda Point HHRAs found that the potential risk for such receptors is within the risk management range of 1.0E-04 to 1.0E-06. An ERA was performed at the same OUs and concluded that the depth of the former subtidal area and marsh crust precluded a completed exposure pathway for ecological receptors.

Although currently no complete exposure pathway is present to the subtidal area and marsh crust contamination, other than for construction workers at Alameda Point, unacceptable risk to human health and the environment is possible if the soil were brought to the surface where it could remain as a source of exposure.

Beneficial Use of Groundwater at Alameda Facility/Alameda Annex

The Navy evaluated shallow groundwater conditions and ambient groundwater quality in the base-wide beneficial use report for the shallow water-bearing zone at Alameda Facility/Alameda Annex (TtEMI 1999d). Deeper zones were not evaluated because the results of the screening level risk assessment indicated that deep groundwater presents no unacceptable risks to human health and the environment. The Navy concluded, and the RWQCB concurred, that shallow groundwater beneath Alameda Facility/Alameda Annex does not have a potential beneficial use as a drinking water supply because of elevated total dissolved solids (TDS) concentrations, its low sustainable yield, the inability to construct groundwater production wells in the shallow groundwater in compliance with local and state construction standards, and the availability of an existing freshwater supply from East Bay Municipal Utility District (RWQCB 1999). The Navy has also determined that shallow groundwater has limited other beneficial uses, such as agricultural supply, industrial use supply, and freshwater replenishment. In addition, groundwater modeling indicates that contaminants in groundwater will not migrate to the Oakland Inner

Harbor or other surface water bodies at concentrations that could cause an unacceptable human health or environmental impact (TtEMI 1998c).

Feasibility Study Focus

Although the RIs for Alameda Facility/Alameda Annex and Alameda Point determined that the contaminants in the groundwater at Alameda Facility/Alameda Annex only, and in the marsh crust and former subtidal area at both facilities pose no current risk to human health or the environment, the Navy has determined that additional exposure pathways may exist. Because of these additional exposure pathways, further action under the National Contingency Plan (NCP) is warranted. These pathways include potential future exposure due to uncontrolled placement of marsh crust and former subtidal area sediments at the surface where they may pose an unacceptable risk to human health and the environment, and potential future ingestion of groundwater due to accidental long term ingestion or use of wells installed in the shallow aquifer in violation of current well construction requirements. At the request of EPA and the DTSC, the Navy is conducting this FS to evaluate remedial action in the event of the following two potential future scenarios occurring: (1) construction activities at both facilities resulting in contaminants from the former subtidal area and marsh crust being brought to the surface from excavation and (2) groundwater consumption at Alameda Facility/Alameda Annex by future residents as the result of long term accidental use of groundwater, or construction of wells in violation of current well construction standards that essentially restrict drawing water from shallow water-bearing zone. It is assumed that these scenarios could result in unacceptable human health risks, although the magnitude of these potential risks has not been determined. As requested by EPA and DTSC, the FS is focused on a limited number of specific alternatives for the marsh crust and former subtidal area at both facilities and groundwater at Alameda Facility/Alameda Annex only. As requested by EPA and DTSC, the FS is focused on a limited number of specific alternatives for the marsh crust and former subtidal area and groundwater:

- **Marsh Crust at Alameda Facility/Alameda Annex and Former Subtidal Area and Marsh Crust at Alameda Point:** (1) no action, (2) institutional controls, (3) excavation and off-site disposal, and (4) excavation and on-site treatment with thermal desorption
- **Groundwater at Alameda Facility/Alameda Annex:** (1) no action and (2) institutional controls and groundwater monitoring

Former Subtidal Area and Marsh Crust

EPA guidance requires that the no action alternative (Alternative 1) be considered as a basis for comparison to the other alternatives.

Institutional controls (Alternative 2) for the former subtidal area and marsh crust, requires that the DTSC enter into a land use covenant to restrict future site occupants from excavating into the marsh crust unless proper procedures are taken to ensure that workers are not unduly exposed and that all contaminated material brought to the surface undergoes appropriate disposal.

The remaining two alternatives for marsh crust consist of active measures: excavation and off-site disposal and excavation and on-site treatment and disposal. These alternatives have been included at the request of EPA and DTSC to evaluate the feasibility of removing contaminants from the marsh crust and compare the feasibility and cost of doing so with the feasibility and cost of Alternatives 1 and 2. The FS shows that while both of the active removal alternatives would be highly protective of human health and the environment in the long term, both alternatives would be extremely difficult to implement and would cause profound disruption of large areas at Alameda Facility/Alameda Annex and Alameda Point. Additionally, the cost of implementing either alternative would be prohibitively expensive.

Except for Alternative 1, all of the alternatives evaluated in this FS for the former subtidal area and marsh crust would be protective of human health and the environment. Active excavation measures that would cause massive disruption of Alameda Facility/Alameda Annex would, however, be impractical to implement, prohibitively expensive, and unjustifiable. Comparing Alternative 1 and Alternative 2, Alternative 2 would provide protection in the event of marsh crust and former subtidal area brought to surface.

Groundwater

As for groundwater, the fact that high TDS renders the groundwater nonpotable with only limited beneficial use makes Alternative 1 nearly as effective as Alternative 2. The State of California Department of Water Resources and Alameda County specify well construction standards that, if enforced, would effectively prohibit the construction of drinking water supply wells in the shallow water-bearing zone at Alameda Facility/Alameda Annex. However, these standards could be changed in the future.

Alternative 1, however, may not protect the public health and the environment because no action would be taken to ensure that site occupants do not use shallow groundwater. Although currently no complete exposure pathway is present to the groundwater contamination at Alameda Facility/Alameda Annex, unacceptable risk is possible if accidental ingestion by humans were to occur for an extended period or if ingestion were to result from well construction inconsistent with current well construction regulations.

Alternative 2 for groundwater, institutional controls and groundwater monitoring, consists of a land use covenant signed by DTSC and reliance on existing well construction standards. The land use covenant would restrict installation of wells to only a few beneficial uses, not including ingestion, and would only allow extraction of groundwater for these beneficial uses or for construction dewatering. The disposal of any such extracted groundwater would have to be conducted in compliance with RWQCB regulations. The land use covenant would be enforceable by DTSC. This alternative also would provide for monitoring to ensure that contaminants are not migrating off the site at concentrations that pose risk to human health or the environment (TtEMI 1998c). Active treatment of groundwater to remove contaminants was not evaluated. Such treatment would not remove high levels of TDS naturally occurring in shallow groundwater and, therefore, would not render groundwater at Alameda Facility/Alameda Annex potable or fit for limited beneficial uses recognized by the RWQCB.

1.0 INTRODUCTION AND SITE CHARACTERIZATION

This base-wide feasibility study (FS) report was prepared under Contract Task Order No. 0236 and 0245 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62474-94-D-7609 (CLEAN II). CLEAN II is administered by the U.S. Department of the Navy (Navy) Naval Facilities Engineering Command, Engineering Field Activity Southwest in San Diego, California. Tetra Tech EM Inc. (TtEMI), formerly known as PRC Environmental Management, Inc. (PRC), has prepared this FS report to address base-wide contamination associated with the marsh crust and groundwater at the Fleet and Industrial Supply Center Oakland Alameda Facility/Alameda Annex (Alameda Facility/Alameda Annex) and contamination associated with the former subtidal area and marsh crust at Alameda Point (formerly Naval Air Station [NAS] Alameda).

A thin, deeply buried layer of historically contaminated sediment known as the "marsh crust" or the "former subtidal area and marsh crust" is found within much of the area of Alameda Point and Alameda Facility/Alameda Annex. This layer is believed to have been formed during the late 1800s to 1920s, when manufactured gas plants and an oil refinery located near the future locations of these facilities are thought to have discharged petroleum waste to adjacent marshlands. The discharge was rich in semivolatile organic compounds, including PAHs. The waste spread over much of the marsh surface through tidal actions, leaving a thin layer of contaminated sediment over the area that would later become the Alameda Point and Alameda Facility/Alameda Annex. Fill material, dredged during improvement of the Oakland Inner Harbor and surrounding San Francisco Bay sediments, was placed as fill on the marsh surface beginning 1887, encapsulating the former subtidal area and marsh crust underneath.

Borings drilled at the facilities have encountered the former subtidal area and marsh crust over a large geographic area that exceeds 700 acres, at depths ranging from four to eighteen feet below ground surface. Concentrations of PAHs such as benzo(a)pyrene, a highly carcinogenic compound, commonly exceed its residential preliminary remediation goal of 0.056 mg/kg by several orders of magnitude within this thin layer. Based on the conceptual model of how the former subtidal area and marsh crust was deposited, the marsh crust is believed to exist throughout the area in a reasonably predictable, planar zone, but may not exist as a continuous layer because of the presence of tidal channels and other phenomena affecting the original deposition.

Organic and inorganic chemicals are present in groundwater in the shallow water-bearing zone below the Alameda Facility/Alameda Annex. No chemicals were detected at levels of concern in the deep groundwater. The source of the contamination in the shallow groundwater within Alameda Facility/Alameda Annex is not known; however, for purposes of this FS, the contamination is assumed to originate at least in part from releases of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances. Some floating product that is not a CERCLA hazardous substance is present on the shallow groundwater near IR04 and IR06. This contamination is being addressed under a separate petroleum cleanup action in cooperation with the California Regional Water Quality Control Board, San Francisco Region (RWQCB).

Further investigation of the contamination in the former subtidal area and marsh crust and the groundwater is not likely to provide significantly better information regarding the exact location of the contamination or its original source. For this reason, no additional investigatory sampling is recommended.

This FS presents an evaluation and comparative analysis of potential alternatives for the remediation of the former subtidal area at Alameda Point, the marsh crust at both facilities, and groundwater at Alameda Facility/Alameda Annex. This FS is being conducted under CERCLA and in accordance with Title 40 of the Code of Federal Regulations (40 CFR) Part 300, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

The objectives of this FS are to:

- Identify remedial action objectives (RAO),
- Evaluate potential remedial alternatives, and
- Provide a comparative analysis of the remedial alternatives.

This FS does not include detailed development of general response actions (GRA) or detailed screening of alternatives that are typically contained in an FS. This streamlined approach is consistent with the U.S. Environmental Protection Agency (EPA) management principles defined in the NCP. The NCP, at Title 40, Code of Federal Regulations (CFR) Subsection 300.43(a), (40 CFR 300.43(a)) provides that "site-specific data needs, the evaluation of alternatives, and the documentation of the selected remedy should reflect the scope and complexity of the site problems."

1.1 PURPOSE AND ORGANIZATION

In the NCP, 40 CFR Subsections 300.430(a)(1)(i) through (iii), EPA sets goals, principles, and expectations for remedy selection and program management under CERCLA. The Navy has prepared this FS consistent with the NCP.

As discussed in more detail below, although the RIs for Alameda Facility/Alameda Annex and Alameda Point determined that the contaminants in the groundwater at Alameda Facility/Alameda Annex only, and in the marsh crust and former subtidal area at both facilities pose no current risk to human health or the environment, the Navy has determined that additional exposure pathways may exist. Because of these additional exposure pathways, further action under the National Contingency Plan (NCP) is warranted. These pathways include potential future exposure due to uncontrolled placement of marsh crust and former subtidal area sediments at the surface where they may pose an unacceptable risk to human health and the environment, and potential future ingestion of groundwater due to accidental long term ingestion or use of wells installed in the shallow aquifer in violation of current well construction requirements. At the request of EPA and DTSC, the Navy is conducting this FS to evaluate remedial action in the event of the following two potential future scenarios occurring: (1) construction activities at both facilities resulting in contaminants from the former subtidal area and marsh crust being brought to the surface from excavation and (2) groundwater consumption at Alameda Facility/Alameda Annex by future residents as the result of long term accidental use of groundwater, or construction of wells in violation of current well construction standards that essentially restrict drawing water from the shallow water-bearing zone. It is assumed that these scenarios could result in unacceptable human health risks, although the magnitude of these potential risks has not been determined. As requested by EPA and DTSC, the FS is focused on a limited number of specific alternatives for the marsh crust and former subtidal area at both facilities and groundwater at Alameda Facility/Alameda Annex only.

The organization of this report generally follows the suggested format found in EPA's interim final guidance document for conducting RIs and FSs under CERCLA (EPA 1988). As discussed above, this FS is based on data from the Alameda Facility/Alameda Annex RI (PRC 1996a) and on data from a later risk assessment regarding potential uses of groundwater other than consumption (Newfields Inc. 2000), as well as data from the RIs for Alameda Point OU-1 RI (TtEMI 1999a), pending OU-2 RI, and the OU-3 RI (TtEMI 1999c). This FS combines this data to develop a more coherent description of the nature and extent of the contamination, which is common to both facilities. This discussion is then used as a basis for selecting and evaluating remedial alternatives aimed at addressing the marsh crust and subtidal area, which is common to both facilities, as well as the groundwater at Alameda Facility/Alameda Annex.

In the remainder of Chapter 1, the chemicals found in the groundwater, the marsh crust, and subtidal area are described. In Chapter 2, RAOs are identified, and specific alternatives that could be used to remediate chemicals in the former subtidal area and marsh crust and shallow aquifer groundwater are defined. In Chapter 3, the alternatives are evaluated relative to the criteria required by the NCP (40 CFR Section 300.430(e)) and are then compared with one another. All figures and tables referenced in this FS are found in the back of the document following the reference section.

1.2 BACKGROUND INFORMATION

This section presents information about each facility, including descriptions of each; its history, environmental setting, and cultural resources; and previous investigations.

1.2.1 Facility Description

This section provides general information about the facilities and identifies the sites that are not included in this FS because they were addressed under previous FSs.

Alameda Facility/Alameda Annex

The Alameda Facility/Alameda Annex occupies about 143 acres and is located about 1 mile southeast of the FISCO main base and less than 1 mile east of the former NAS Alameda, now known as Alameda Point, along the southern shore of the Oakland Inner Harbor in Alameda, California (Figure 1-1). The site is constructed in an area that used to be marshland (Figure 1-2) until it was covered with fill soil in the early to mid-1900s (Figures 1-3 and 1-4). The fill soil varies in depth, partly because much of the eastern end of the area in the vicinity of Alameda Facility/Alameda Annex, was laced with tide channels, which are mapped on Figures 1-2 and 1-3, and are depicted in cross section on Figure 1-5. The source of the fill materials is believed to be dredge spoils from the Oakland Inner Harbor.

Several installation restoration (IR) sites at the facility were identified in the past as having potential environmental contamination. Those sites for which further investigations determined a potential for contamination were studied under the RI. Those sites that the RI found to pose risk to human health or the environment were addressed under previous FSs and will not be further discussed here. The following list includes all the initially identified sites (IR site 01 [IR01] through IR08), as shown on Figure 1-6:

- IR01 – Former warehouse area
- IR02 – Screening lot and scrapyard area, also known as solid waste management unit (SWMU) 1
- IR03 – Former automobile maintenance rack, also known as SWMU 3
- IR04 – Former paint spray booth, also known as SWMU 4
- IR05 – Former underground storage tank (UST) and fuel dispensing system, also known as area of concern (AOC) 1
- IR06 – Paint and material storage area, also known as AOC 2
- IR07 – Diesel fuel spill area, also known as AOC 3
- IR08 – Facility storm water drainage system, also known as AOC 8

Alameda Point

Alameda Point occupies 2,675 acres and is located on the western end of Alameda Island, adjacent to Alameda Facility/Alameda Annex. Most of the land at Alameda Point was created by filling existing tidelands, marshlands, and sloughs. Fill materials are dredge spoils from the surrounding San Francisco Bay, the Seaplane Lagoon, and the Oakland Inner Harbor.

Twenty-five IR sites at Alameda Point were identified in the past as having potential environmental contamination as shown on Figure 1-6. These sites are currently being evaluated under four separate OU RIs and FSs and will not be further discussed here. These sites include the following:

- Site 1 – Disposal area
- Site 2 – West beach landfill
- Site 3 – Abandoned fuel storage area
- Site 4 – Aircraft engine facility (consisting of Building 360)
- Site 5 – Aircraft rework facility (consisting of Building 5)
- Site 6 – Aircraft maintenance and repair facility (consisting of Building 41)
- Site 7 – Navy exchange service station (consisting of Building 459)
- Site 8 – Pesticide storage area (consisting of Building 114)
- Site 9 – Aircraft paint-stripping operation (consisting of Building 410)
- Site 10 – Missile rework facility (consisting of Building 400)
- Site 11 – Engine test cell (consisting of Building 14)

- Site 12 – Power plant (consisting of Building 10)
- Site 13 – Former oil refinery
- Site 14 – Fire training area
- Site 15 – Former transformer storage area (consisting of Buildings 301 and 389)
- Site 16 – Shipping container storage area
- Site 17 – Seaplane Lagoon
- Site 18 – Storm sewer system
- Site 19 – Hazardous waste storage
- Site 20 – Oakland Inner Harbor
- Site 21 – Ship fitting and engine repair (consisting of Buildings 162 and 14)
- Site 22 – Former service station (consisting of Building 457)
- Site 23 – Missile rework facility (consisting of Building 530)
- Site 24 – Pier 1 and 2 sediments
- Site 25 – Parcel 182

1.2.2 Facility History

Until the 1920s, the facilities and their surrounding areas existed as undeveloped marshlands and tidal flats along the San Francisco Bay fringe. The area south and east of the facilities consisted primarily of residential properties. Before 1930, at least two large industrial sites (an oil refinery and a borax processing plant) were located on the western tip of Alameda Island. The oil refinery was located southeast of the borax plant at the southwestern corner of Main Street and Pacific Street. The borax plant was also located on the dry land at the southeastern corner of what is now West Atlantic Avenue and Orion Street (Sanborn-Ferris Map Company [Sanborn] 1897). Figure 1-2 shows the original shoreline of the area, the former locations of the oil refinery (Pacific Coast Oil Works), and two manufactured gas plants. As discussed in a report on the regional history (International Technology Corporation [IT] 1998a), a number of industrial facilities were present before and during the period that fill soil was being applied to the area.

Many of these industries are believed to have stored and used hazardous materials and generated hazardous wastes during their daily operations and manufacturing processes (PRC 1996a). In particular, lighter hydrocarbon by-products and sludges laden with polynuclear aromatic hydrocarbons (PAH) are likely to have been discharged directly into the waters of San Francisco Bay or Oakland Inner Harbor. Because many of these materials are lighter than water, they would have floated and been transported by tidal flows into the marsh by the historical tidal channels (Figure 1-2). These materials are believed to have been deposited along the sides of the tidal channels and surface of the marsh. This deposited material is the marsh crust that currently exists at an average depth of 15.3 feet bgs at Alameda Facility/Alameda Annex (Figure 1-5), as determined by soil samples collected during the RI (PRC 1996a). These same materials appear to have been deposited in sediment as deep as minus 1 foot mean lower low water (MLLW), which is identified as the subtidal area in this FS. The history of the two facilities is described below.

Alameda Facility/Alameda Annex

From 1900 to 1939, the area now composing Alameda Facility/Alameda Annex was covered with fill soil obtained from unknown sources (IT 1998a), although the fill probably came from dredge spoils from the Oakland Inner Harbor. The dates during which various portions of the area were covered with fill are shown on Figure 1-4.

A commercial airport known as the San Francisco Bay Airdrome (Airdrome) was constructed in the mid-1920s in the area that is the current location of the southern portion of the facility. The Airdrome consisted of a 2,500-foot runway, a passenger terminal, and an aircraft maintenance hangar. Maintenance of aircraft would likely have involved use and storage of hazardous materials and generation of associated wastes in the form of solvents, paints, and petroleum-based products (such as aircraft fuel and lubricating oil). The Airdrome reached peak operation by 1932, serving about 11,000 customers per month. Wartime activities at nearby NAS Alameda caused air traffic conflicts, resulting in closure of the Airdrome in 1941 (PRC 1996a).

The U.S. government purchased the property that is now the facility between 1946 and 1966. An elongated piece of property belonging to Southern Pacific Railroad bisects the facility; the property consists of multiple sets of railroad tracks. The facility is composed of two parts: the Alameda Facility in the northern portion of the facility and the Alameda Annex in the southern portion. The property composing the Alameda Facility was occupied by the Alameda Medical Depot of the U.S. Army as of 1945, before the site was purchased by the federal government, and was later used by Sharpe Army Depot. The portion of the facility south of the Southern Pacific railroad tracks was purchased by the U.S. government in 1946, and the portion north of the Southern Pacific railroad tracks was purchased in 1966 (VISTA Information Solutions, Inc. 1996).

In 1964, command of the Alameda Facility was transferred to Naval Supply Center (NSC) Oakland. The property composing the Alameda Annex was assigned to NAS Alameda in 1951. In 1980, the Alameda Annex was also transferred to NSC Oakland (Western Division Naval Facilities Engineering Command

[NAVFAC] 1988). The Alameda Facility/Alameda Annex, in conjunction with NSC Oakland, served as the main supply facility supporting Department of Defense (DoD) operations of military fleets and shore activities in the Pacific Basin. The facility was scheduled for closure in 1998 and was actually closed in September 1998.

Alameda Point

The western tip of Alameda Island (prior to the construction of Alameda Point) was farmed before becoming an industrial and transit center. Railroad yards and rights-of-way for Southern Pacific, Central Pacific, and small local railways were built over the site and sloughs to the north. The western terminus for the transcontinental railroad was at the southeastern corner of the site for a short period in 1869. The U.S. Department of the Army (Army) acquired the western tip of Alameda from the City of Alameda in 1930 and began construction activities in 1931. In 1936, the Navy acquired title to the land from the Army and began building NAS Alameda in response to the military buildup in Europe before World War II. The construction involved filling the natural tidelands, marshes, and sloughs between the Oakland Inner Harbor and the western tip of Alameda Island (Figure 1-4). The fill largely consisted of dredge spoils from the surrounding San Francisco Bay and Oakland Inner Harbor. After the United States entered the war in 1941, the Navy acquired more land to the west of the installation. Following the end of the war in 1945, the installation continued its primary mission of providing facilities and support for fleet aviation activities. During its operations as an active naval base, the installation provided berthing for Pacific Fleet ships and was a major center of naval aviation.

Alameda Point was identified for closure in September 1993. The installation ceased all naval operations in April 1997, and the Navy is currently in the process of returning the land back to the City of Alameda. The City of Alameda is working with the Alameda Reuse and Redevelopment Authority to determine appropriate reuse activities for the land.

1.2.3 Demography and Land Use

Alameda Facility/Alameda Annex and Alameda Point are located in the City of Alameda. For the purposes of this FS, future land use at both facilities is assumed to be residential; however, actual land use is expected to be a mixture of commercial, industrial, and residential. Alameda Point is also expected to include recreational land use. Facility-specific information about demography and land use is provided below.

Alameda Facility/Alameda Annex

Alameda Facility/Alameda Annex is zoned as an M-2-G general industrial (manufacturing) district with a special government-combining overlay. The Oakland Inner Harbor, which is north of the facility, contains a ferry terminal, shipyards, several marinas and yacht clubs. The area east of the facility encompasses commercial and industrial properties, including the former location of a Phillips Petroleum bulk storage plant. The area south of the facility consists of residential developments, including housing, elementary schools, a middle school, and the College of Alameda (PRC 1996a). The area west of the facility is occupied by Alameda Point.

Alameda Point

Alameda Point is currently a mixed-use area with industrial and office space; land uses at Alameda Point formerly included military operations and family housing. The Oakland Inner Harbor, north of the facility, contains a ferry terminal, shipyards, several marinas and yacht clubs. The area east of the facility encompasses Alameda Facility/Alameda Annex. The area southeast of the facility consists of residential developments, including housing, elementary schools, a middle school, and the College of Alameda. San Francisco Bay lies to the west of the facility.

Alameda Point is undergoing base closure and will be released for public use upon completion of closure under the Base Realignment and Closure Act (BRAC) of 1988 and the BRAC of 1990.

1.2.4 Geology

Surface and near-surface soil at both facilities consists of artificial fill placed during the historical filling of the tidal marshlands and as part of construction activities during site development. The fill material is characterized by poorly graded fine- to medium-grained sand, clay, and silt dredged from the tidal flats in the region and mixed with material from the Merritt Sand Formation. The artificial fill materials are believed to be dredge spoils from the surrounding San Francisco Bay, the Seaplane Lagoon, and the Oakland Inner Harbor.

A peat and grass marshland layer (the marsh crust) underlies much of the artificial fills at the facilities; it was recognized during previous geotechnical investigations (Lee and Prazsker 1969, 1979). Data indicate that the marsh crust contains contamination that may be associated with historical (pre-Navy) industrial activities in the region (such as in the Oakland Inner Harbor) (PRC 1996a).

The Bay Mud layer, underlying the marsh crust layer, consists of recent sediment deposited in an estuarine environment. The Bay Mud generally consists of silt and gray to black clay with laterally discontinuous, poorly graded, silty and clayey sand layers.

The Merritt Sand Formation underlies the Bay Mud across most of the facilities. The Merritt Sand is composed of brown, fine- to medium-grained, poorly graded sand. The Merritt Sand is generally laterally continuous throughout the facilities, except where it is bisected by a major paleochannel that is filled with thicker deposits of the Bay Mud.

Alameda Facility/Alameda Annex

The fill at Alameda Facility/Alameda Annex is present to depths ranging from about 10 feet bgs in the northern portion of the facility to 20 feet bgs in the southern portion. The marsh crust, which underlies the fill at Alameda Facility/Alameda Annex, was observed during investigations as an organic-rich peat and grass layer that is about 2 to 6 inches thick at depths that range from approximately 10 to 20 feet bgs (PRC 1996a). Immediately below the marsh crust layer is the Bay Mud layer, which underlies the fill across Alameda Facility/Alameda Annex. The Merritt Sand Formation underlies the Bay Mud across most of Alameda Facility/Alameda Annex.

Alameda Point

Alameda Point was constructed by placing the fill not only on the former marshlands, but also beyond the limits of the former marshlands and into the subtidal area of the San Francisco Bay.

The artificial fill material was emplaced from 1887 to as late as 1975 (Figure 1-4). The thickness of the artificial fill is a result of natural variation in the depth of the estuary before filling activities, which were conducted starting in the late 1800s. The artificial fill is therefore thinnest at the eastern edge and thickens to 20 feet at the western edge of the Alameda Point.

Underlying artificial fill is the marsh crust in the eastern portion and former subtidal area to the west. In the eastern portion of the Alameda Point facility, a layer of marsh crust is found below the fill material and on top of the Bay Mud.

Further to the west, a high organic content layer is typically located under the fill and on top of the Bay Mud in an area that was mapped as tidal flats in an 1856 U.S. Coast and Geodetic Survey as noted in Radbruch (1957). The high organic content layer is a layer of decayed organic matter incorporated into the mineral soil, typically from plant detritus (such as decayed stems and leaf skeletons or humus) and algae. This layer makes up the subtidal zone that is one of the subsurface layers being evaluated in this FS.

At Alameda Point, immediately below marsh crust is the Bay Mud. The thickness of the Bay Mud ranges from 10 to 95 feet across much of Alameda Point. The Bay Mud is thin or absent in the southeastern region of the installation.

The Merritt Sand Formation also underlies the Bay Mud across much of Alameda Point. The Merritt Sand is generally laterally continuous across Alameda Point, except where it is bisected by a major paleochannel that is filled with thicker deposits of the Bay Mud.

1.2.5 Hydrogeology

Fill material above the Bay Mud constitutes the shallow unconfined water-bearing zone beneath Alameda Facility/Alameda Annex. The Bay Mud forms an aquitard between the shallow groundwater and the Merritt Sand that composes much of the deeper confined aquifer beneath the facility (PRC 1996a). In the region, the Bay Mud varies in thickness from a few inches to 95 feet (PRC 1996a).

Groundwater flow in the deeper confined aquifer at Alameda Facility/Alameda Annex was evaluated during two monitoring events. The flow was determined to be to the west-southwest in August 1992 and to the northeast in January 1993 (PRC 1993). The shift in flow in the deeper confined aquifer is concluded to be the result of tidal influence. Regional groundwater in the shallow aquifer at Alameda Facility/Alameda Annex flows to the northwest, towards the Oakland Inner Harbor. This means that the groundwater generally flows off site into the Oakland Inner Harbor. Aquifer tests indicate that the aquitard acts as an effective hydraulic barrier between the deeper confined aquifer and the shallow unconfined water-bearing zone.

Over most of Alameda Point, the shallow groundwater is referred to as the first water-bearing zone (FWBZ). The saturated thickness of the FWBZ ranges from less than 10 feet along the eastern boundary to over 30 feet along the western shoreline. The depth to groundwater ranges from 2 to 8 feet bgs and averages 3 to 5 feet bgs. The elevation of the water table in the FWBZ ranges from 3 to 12 feet MLLW and is typically 6 to 9 feet MLLW. Groundwater flow in the FWBZ is primarily horizontal and generally flows radially from the central portion of Alameda Point towards the San Francisco Bay, Oakland Inner Harbor, and the Seaplane Lagoon. In the southeastern region of Alameda Point, groundwater in the

FWBZ generally flows from the east or northeast inland areas to the west or southwest towards the Seaplane Lagoon and San Francisco Bay. Groundwater flow is impacted locally near industrial buildings by preferential flow paths such as storm water drains and underground utility conveyance structures. Shallow groundwater recharge is attributed to vertical infiltration from precipitation; horticultural irrigation; and leaking water supply, sewer, and stormwater pipes. Tidal inundation of wetland areas may also contribute recharge to shallow groundwater.

1.2.6 Natural Resources

The Oakland Inner Harbor, which is an arm of the San Francisco Bay, is adjacent to the northern boundary of Alameda Facility/Alameda Annex. The shoreline of Oakland Inner Harbor is almost entirely modified by human activity, and a variety of industries are located along its entire length (including port facilities, shipbuilding and repair facilities, sand and gravel off-loading areas, and marinas).

Landscaped areas around office buildings at Alameda Facility/Alameda Annex are characterized by ornamental trees and shrubs and small grass lawns. Aquatic areas are present on the northern portion of the facility, bordering the Oakland Inner Harbor. Although harbor seals and birds, including California brown pelicans, double-crested cormorants, and several species of gulls, have been observed in the inner harbor area, these species do not nest or feed at Alameda Facility/Alameda Annex because it offers no supporting habitat. Similarly, of the wildlife species in the Bay Area that are classified as endangered or threatened by either the state and federal government, none nests or feeds at Alameda Facility/Alameda Annex (Port of Oakland and U.S. Army Corps of Engineers 1994).

Alameda Point is almost entirely modified by human activity, and a variety of industries and activities are located through the facility (including port facilities, aircraft repair facilities, office buildings, runways, and landfills). Alameda Point, including contiguous and noncontiguous properties, such as constructed breakwaters, contains nine terrestrial and aquatic wildlife habitats. Major habitat types currently present at Alameda Point are described in the OU-1 RI report (TtEMI 1999a) and include: open water areas; estuarine intertidal emergent wetlands; paved runway areas; non-native grassland; ruderal upland vegetation; disturbed areas; beach, urban, and ornamental landscapes; and riprap. Several special status species have been identified that occur or are expected to occur at Alameda Point (U.S. Fish and Wildlife Service [USFWS] 1993; TtEMI 1999a).

1.2.7 Previous Investigations

Alameda Facility/Alameda Annex and Alameda Point have undergone investigations for environmental contamination. These investigations are discussed below

Alameda Facility/Alameda Annex

Several previous investigations have been conducted at various areas within Alameda Facility/Alameda Annex in which samples were collected of shallow soil (soil from the surface to 10 feet bgs), deep soil (soil from 10 feet to 22.5 feet bgs), and shallow and deep groundwater. The most complete description of these investigations can be found in the Alameda Facility/Alameda Annex RI report (PRC 1996a). After the evaluation of sampling results, chemicals of potential concern (COPC) within the shallow and deep soil and the shallow groundwater were selected for evaluation in an HHRA, as described in Chapter 7 of the RI report (PRC 1996a). The deep groundwater was evaluated in the RI report, which concluded that the chemicals were only detected sporadically and at low concentrations and therefore were not considered COPCs.

COPCs established for deep soil and shallow groundwater were grouped into five categories: SVOCs, polychlorinated biphenyls (PCB), TPH, metals, and volatile organic compounds (VOC). RI results indicate that SVOCs, TPH, and metals are widely distributed in shallow groundwater. PCBs were found mostly in surface soil and only at IR02, where two removal actions have been completed to remove PCB- and metal-contaminated soil (PRC 1996b; TtEMI 1999b). The Navy is preparing to conduct a remedial action for additional surface soil contaminated with PCBs and cadmium at IR02. TPH, SVOCs, and VOCs were detected in the marsh crust (PRC 1996b).

Alameda Point

Several phases of investigation have been conducted at the 25 IR sites at Alameda Point for soil, sediment, and groundwater media. Due to the large number of investigations and IR sites, a basewide RI report has not been prepared for Alameda Point. Instead, four OUs were developed to streamline the investigative and reporting process. To date, RI reports for OU-1 (TtEMI 1999a) and OU-3 (TtEMI 1999a and 1999c) have been prepared; the RI report for OU-2 currently in production. Because this FS only addresses PAHs within the former subtidal area and marsh crust, the results of the OU-1, -2, and -3 RI reports will not be summarized. Instead, investigative results for PAHs related to the former subtidal area and marsh crust will be presented in Sections 1.3.1 and 1.3.2.

1.3 SOURCE AND EXTENT OF CONTAMINATION

This section summarizes the conclusions of the RIs regarding the probable sources and extent of contaminants detected in the former subtidal area at Alameda Point, the marsh crust at both facilities, and in shallow groundwater across all of Alameda Facility/Alameda Annex. Shallow groundwater at Alameda Point is not evaluated under this FS.

1.3.1 Alameda Facility/Alameda Annex Marsh Crust

Section 1.0, describes the formation of the marsh crust at Alameda Facility/Alameda Annex. The extent of the marsh crust as shown in Figure 1-6 was determined in two ways: (1) review of boring logs prepared during installation of monitoring wells or borings at all of the IR sites to determine the depth of the transition from fill to the Bay Mud and (2) examination of soil analytical data at IR02 to determine chemical characteristics of the marsh crust and the depth and location of samples with higher SVOC concentrations.

Boring logs for all monitoring wells and boreholes installed at Alameda Facility/Alameda Annex are contained in the RI report (PRC 1996a). Fifty-seven wells and boreholes extending to depths greater than 10 feet were installed at Alameda Facility/Alameda Annex. Thirty-seven of the 57 wells or boreholes encountered the marsh crust. The mean depth of the marsh crust was found to be 15.3 feet bgs. Three of the boring logs (for wells S22, S31, and S42) encountered the interface of the fill and the Bay Mud at 8, 7.5, and 9 feet bgs, respectively. The remaining 34 logs showed the interface and the marsh crust to be present below 10 feet. Based on available lithologic data, the marsh crust appears to be present as a thin layer between 10 and 20 feet bgs. A figure showing the depth to the top of the marsh crust was not prepared because not enough data exists to map the marsh crust surface. The marsh crust geometry is expected to be complex within Alameda Facility/Alameda Annex because of the large number of tidal channels dissecting the surface of the tidal marshland.

Analytical data were collected on the marsh crust in and around IR02. Results of analyses of soil samples indicated high concentrations of PAHs and TPH. PAHs are common components of TPHs and are the specific components identified in the HHRA as posing potential human health risks. The TPHs do not contribute to human health risk, so they are not discussed further in this FS. Because of the site's history, geology, and previous investigations, all marsh crust underlying Alameda Facility/Alameda Annex is assumed to contain PAHs in roughly similar concentrations found at IR02.

1.3.2 Alameda Point Former Subtidal Area and Marsh Crust

Alameda Point was constructed by placing artificial fill material on top of a subtidal area and a tidal marshland. The eastern portion of Alameda Point was constructed on top of the same tidal marshland as Alameda Facility/Alameda Annex, while the central and southeastern portion of Alameda Point was constructed on a subtidal area adjacent to the tidal marshland and the original Alameda Island landmass (Figure 1-6). The western portion of the facility was constructed beyond the subtidal area, directly in the San Francisco Bay. Deposition of the same layer of refinery by-products and sludges that compose the marsh crust at Alameda Facility/Alameda Annex appears to have occurred on both the tidal marshland and former subtidal area at Alameda Point.

The extent of the former subtidal area and marsh crust was determined in two ways: (1) review of soil, monitoring well, and geotechnical boring logs and (2) examination of soil analytical data throughout Alameda Point to determine chemical characteristics of the former subtidal area and marsh crust area and the depth and location of samples with higher SVOC concentrations.

Logs for all soil, monitoring well, and geotechnical boreholes installed at Alameda Point are contained in the OU-1 RI report (TtEMI 1999a). Data from 133 boreholes extending to depths below the artificial fill-Bay Mud interface were used to define the lateral extent and chemical characteristics of the former subtidal area and the marsh crust. Figure 1-6 shows the extent of the subtidal area, which was defined by a line of equal elevation corresponding to negative 1 foot MLLW. Mobilization of contaminants by tidal fluctuation at elevations lower than negative 1 foot MLLW was assumed to be insignificant. This assumption is supported by SVOC data presented on Figures 1-7 through 1-10, which show elevated levels of benzo(a)pyrene, benzo(a)anthracene, indeno(1,2,3-cd)pyrene, and benzo(b)fluoranthene above negative 1 foot MLLW. These four SVOCs were selected for evaluation based on their high frequency of occurrence and potential to pose a risk to human health. Chemical data used to prepare the four figures are presented in the OU-1 RI report (TtEMI 1999a), OU-2 RI report (pending), and OU-3 RI report (TtEMI 1999c). Figure 1-11 shows the depth to the top of the former subtidal area and marsh crust at Alameda Point.

1.3.3 Alameda Facility/Alameda Annex Groundwater

This section describes shallow groundwater at Alameda Facility/Alameda Annex only. Shallow groundwater at Alameda Point is currently under evaluation and is not included in this FS.

The depth to shallow groundwater in the artificial fill at Alameda Facility/Alameda Annex varied between approximately 2 and 12 feet bgs, based on water levels measured during the monitoring program from June 1994 to December 1996. In general, shallow groundwater is found at about 6 feet bgs. Shallow groundwater generally flows towards the north, northeast, and northwest and discharges to the Oakland Inner Harbor; however, significant local variations (such as groundwater depressions, mounds, and convergent and divergent flow zones) are present in groundwater flow patterns Alameda Facility/Alameda Annex. Shallow groundwater flow is complex; however, flow patterns in these directions were found to be relatively consistent throughout the monitoring program.

Groundwater samples collected from the shallow wells were analyzed for VOCs, SVOCs, pesticides, PCBs, metals, TPH, and total dissolved solids (TDS). Analytical sampling results from the monitoring program indicate wide distribution of organic and inorganic compounds in shallow groundwater. These chemicals were detected throughout IR02 and IR03, and in the adjacent housing area within Alameda Point. Isolated contaminant plumes were also detected at IR04, IR05, and IR06. Some groundwater contamination was also detected at IR07. Sampling of groundwater from beneath the Bay Mud aquitard found no chemicals at levels of concern. In addition, aquifer tests indicated no hydraulic connection between the shallow groundwater and the Merritt Sand aquifer. As a result, the Bay Mud forms an effective aquitard below the shallow water-bearing unit.

Petroleum-based compounds, which include aromatic VOCs (such as benzene, toluene, ethylbenzene, and xylenes), PAHs (such as naphthalene, phenanthrene, acenaphthylene, and fluoranthene), and TPH compounds were detected in shallow groundwater at IR02 and IR03. Petroleum-contaminated groundwater underlies most of IR02 and IR03; however, the plume appears to be limited in lateral extent to the east and south of IR02. The highest detections of benzene, however, have consistently been found in the adjacent housing area within Alameda Point. The plume has generally migrated to the north-northwest, the direction of groundwater flow. Groundwater modeling determined that this plume does not present an environmental risk (see Section 1.6). Petroleum concentrations in groundwater vary considerably at IR02 and IR03, indicating that multiple potential source areas may have contributed to form a commingled plume.

Petroleum-contaminated groundwater was detected in several shallow wells at IR04 and IR06, the former paint booth and storage area. Free petroleum product was detected in well S27 at IR04 and IR06 during the September and December 1994 monitoring events. Free product was not detected in other wells at IR04 and IR06.

Petroleum compounds were detected in isolated shallow groundwater samples collected at IR05. Detected concentrations were relatively low (less than 3.1 milligrams per liter [mg/L]), indicating that petroleum-contaminated groundwater may be localized in this area. Low TPH concentrations (less than 0.3 mg/L) were detected in groundwater samples collected from IR07.

Several different metals were detected in shallow groundwater during the sampling program. Metals that were detected at relatively high concentrations in various wells include copper, lead, nickel, silver, and zinc. In general, the highest metal concentrations were reported in wells located at IR02 and IR03; however, distribution of metal concentrations varied notably across the facility.

TDS concentrations in shallow groundwater generally ranged from an average low of 406 mg/L at well S34 to an average high of 38,463 mg/L at well PW12. The highest TDS concentrations were reported to the south and west of IR02 and IR03. TDS concentrations generally decreased towards the north. TDS concentrations in shallow groundwater underlying the facility are typically greater than 3,000 mg/L and in some areas, greater than 10,000 mg/L.

Contaminant concentrations at most wells did not vary significantly during the nine monitoring events, although some notable temporal variations and trends were present in detected contaminant concentrations at a few wells.

1.4 BENEFICIAL USES OF GROUNDWATER

The Navy conducted a basewide groundwater beneficial use study to evaluate the existing and potential beneficial uses of groundwater in the shallow water-bearing zone at Alameda Facility/Alameda Annex (TtEMI 1999d).

The beneficial use evaluation found that the shallow water-bearing zone groundwater has no existing or potential beneficial use as domestic or municipal water supply or freshwater replenishment. The finding regarding no beneficial use for domestic and municipal water supply is primarily based on high TDS concentrations and low well yield due to potential saltwater intrusion. Shallow groundwater at Alameda Facility/Alameda Annex may, however, have limited beneficial uses as agricultural or industrial water supply. The study findings are summarized below:

- Municipal and Domestic Supply - The shallow water-bearing zone has no potential beneficial use as municipal or domestic supply because (1) current TDS concentrations exceed regulatory criteria in shallow groundwater throughout most of the facility and (2) TDS concentrations are expected to increase in some areas following repair of water distribution system pipes that had been leaking significant quantities of fresh water and had been, in part, responsible for depressed TDS levels in these areas.

- Agricultural and Industrial Use - The shallow water-bearing zone may have potential beneficial uses as agricultural and industrial water supply. However, for several reasons these uses are considered unlikely, first, existing and anticipated increased TDS concentrations exceed recommended levels for many agricultural and industrial uses, second, expected well yield at the facility is not sufficient for most agricultural and industrial uses, and installation and operation of a low-yield well will not be cost effective as compared to the purchase of water available from the municipal supply. Finally, treatment of the water for agricultural or industrial usage will not be cost effective as compared to the purchase of water currently readily available from the East Bay Municipal Utility District (EBMUD).

- Freshwater Replenishment - The shallow water-bearing zone is not a source of freshwater replenishment because (1) the existing and expected TDS concentrations would adversely impact any fresh surface water receiving shallow groundwater, (2) no fresh surface water body is naturally replenished by facility groundwater, and (3) no candidate surface water body for artificial freshwater replenishment exists near the facility.

Further, shallow groundwater at Alameda Facility/Alameda Annex has never been a source for municipal, domestic, industrial, or agricultural use, and no future use of shallow groundwater is planned (EDAW, Inc. 1996). Water has always been and will continue to be supplied to the Alameda Facility/Alameda Annex by EBMUD.

1.5 HUMAN HEALTH RISK ASSESSMENT

Human health risk has been evaluated at both Alameda Facility/Alameda Annex and Alameda Point during the RI phase, as discussed in Sections 1.5.1 and 1.5.2. At Alameda Facility/Alameda Annex, an additional HHRA was conducted after completion of the RI when new exposure pathways were identified, as discussed in Section 1.5.3.

1.5.1 Human Health Risk Assessment Conducted During the Remedial Investigation at Alameda Facility/Alameda Annex

An HHRA was conducted at Alameda Facility/Alameda Annex as part of the final RI report for Alameda Facility/Alameda Annex (PRC 1996a), consistent with EPA's guidelines. The HHRA found that there is no pathway by which humans could be exposed to PAHs in the marsh crust due to its depth. The marsh crust is present at an average depth of 15.3 feet bgs, well below likely construction depths. However, it has since been determined that a pathway may exist if soil from construction activities is brought to the surface during, construction activities, where it could remain as a source of exposure and could pose an unacceptable risk to human health and the environment.

The HHRA also evaluated potential risk posed by groundwater in the upper water-bearing unit at Alameda Facility/Alameda Annex. Because shallow groundwater has been found to have no beneficial uses as drinking water and has limited use for agricultural or industrial supply, the HHRA determined that the only likely route of human exposure is volatilization of VOCs into indoor air spaces. The HHRA found that potential site-wide cancer risks from groundwater under the residential scenario ranged from 4.2E-08 to 7.3E-08. This risk range is well below the NCP's risk management range of "an excess upperbound lifetime cancer risk to an individual from exposure to site contamination of between 1.0E-04 and 1.0E-06 or a hazard index of 1.0."

Three hundred eighteen vapor samples have been collected during four different studies conducted before, during, and after completion of the RI, as documented by TtEMI (1999e). This TtEMI document focuses on the levels of benzene measured in soil vapor because benzene is the most toxic of the VOCs found at the site and because elevated levels of benzene are found in groundwater at several locations at the site. Many of the soil vapor samples with the highest benzene concentrations were collected in soil above groundwater benzene plumes; however, benzene was only detected in 32 out of 318 soil vapor samples collected. In one of the studies discussed in TtEMI 1999e, no benzene was detected in any of the samples. In the other three studies, each detected benzene concentration was used in a vapor transport model to estimate the concentration that could be expected in the interior spaces of a building on that site and the associated human health risk to building occupants. The cancer risk from these 32 detections of benzene ranged from 2.8E-09 to 4.7E-06. The highest risk was identified by a sample in which a particularly high concentration of benzene was detected (17,000 micrograms per cubic meter [$\mu g/m^3$]). This sample appears to be an anomaly because benzene was not detected in any of the eight surrounding samples collected at distances of 50 to 70 feet away. Also, no known source is connected with the location of this sample. If not for this sample, the highest risk is 1.1E-07.

One of the studies (TtEMI 1999e) was a highly focused sampling effort at IR02 in which 214 soil vapor samples were collected according to a sampling grid approximately 50 feet on each side. Figure 1-12 shows the locations of the soil vapor samples superimposed on a map of the estimated groundwater plume. Benzene was detected in 13 of these 214 soil vapor samples at the concentrations shown on

Figure 1-12, including sample T2, in which the highest benzene concentration was found, as discussed above.

An addendum to the TtEMI document (1999e) titled, "Summary of Crawl Space Benzene Air Sampling at Parcel 179 (George P. Miller Elementary School) Alameda Point," describes 10 additional samples collected in 1994 within the crawl space and outside of George P. Miller Elementary School, which is within Alameda Point. No benzene was detected in any of these samples.

The Navy has concluded that contaminants in the marsh crust and groundwater do not currently pose an unacceptable risk to human health or the environment because no complete pathway is present. However, although there is currently no complete exposure pathway to the subtidal area and marsh crust contamination, unacceptable risk is possible if the soil were brought to the surface where it could remain as a source of exposure. In addition, although there is currently no complete exposure pathway to the groundwater contamination at Alameda Facility/Alameda Annex, unacceptable risk is possible if ingestion of groundwater by humans were to occur for an extended period or if ingestion were to result from well construction inconsistent with current well construction regulations. Therefore, the Navy agreed to the request of EPA and DTSC to evaluate a limited number of remedial alternatives based on the following scenarios: (1) future construction activities could bring contaminated marsh crust to the surface where site users could be exposed, and (2) future occupants at Alameda Facility/Alameda Annex may be exposed to contaminants in shallow groundwater from use of shallow groundwater even though it has limited, if any, beneficial uses.

1.5.2 Human Health Risk Assessment Conducted During the Remedial Investigation at Alameda Point

HHRAs have been conducted for soil at OU-1 (TtEMI 1999a), OU-2 (pending), and OU-3 (TtEMI 1999c). The HHRAs determined that no complete exposure pathway is present by which future residents could be exposed to SVOCs associated with the surface of the former subtidal area and marsh crust due to the depth at which SVOCs occur. The HHRAs determined, however, that workers could be exposed to the former subtidal area and marsh crust during construction of building foundations and utility work (2 to 10 feet bgs). The surface of the former subtidal area and marsh crust are present from 4 to 10 feet bgs, within the likely construction depth. Nevertheless, the HHRA determined that the risk under this scenario is less than 1.0E-06 at all IR sites at Alameda Point except for IR25, where the risk was estimated to be from 1.1E-05 to 3.4E-05.

The Navy has concluded that SVOCs on the surface of the former subtidal area and marsh crust do not currently pose an unacceptable risk to human health because no complete exposure pathway is present. Although currently no complete exposure pathway is present to the subtidal area and marsh crust contamination, unacceptable risk is possible if the soil were brought to the surface where it could remain as a source of exposure. Therefore, the Navy agreed, at the request of EPA and DTSC, to evaluate a limited number of remedial alternatives based on the possibility that future construction could bring contaminated material from the former subtidal area and marsh crust to the surface where site users, including future residents, could be exposed.

1.5.3 Additional Human Health Risk Assessment at Alameda Facility/Alameda Annex

After completion of the RI, the Navy concluded that contaminants found in the groundwater underlying the Alameda Facility/Alameda Annex present no unacceptable risk, and that no further action is necessary to address groundwater under the NCP. After completion of the RI, however, additional pathways for human exposure to site contaminants became evident. DTSC and EPA identified the need to evaluate (1) the potential exposure of humans to groundwater through uses other than consumption and (2) the potential exposure of children and adult workers at a new school proposed for the western part of IR02 to indoor air that could be contaminated with VOCs that may volatilize from the contaminated groundwater at the site. To accomplish these objectives, a new HHRA was performed by Newfields Inc. (2000), as discussed below.

The Newfields HHRA selected scenarios based on car wash workers and landscape workers using groundwater from the upper aquifer in order to evaluate the potential risk due to exposure of adults to groundwater from groundwater brought to the surface or in use for industrial beneficial uses. In both cases, the resulting hazard index (HI) calculated was found to be below 1, and the cancer risk was found to be either less than, or within the risk management range of, 1.0E-06 to 1.0E-04. The actual calculated risks for IR02 were landscape worker (8.0E-05) and car wash worker (1.0E-05), and the actual calculated risks for IR04/06 were landscape worker (1.0E-06) and car wash worker (2.0E-06).

The Newfields (2000) HHRA evaluated children and adult workers to evaluate the potential risk due to exposure to indoor air that could be contaminated with VOCs that may volatilize from the contaminated groundwater at a new school proposed for the western part of IR02. In both cases, the resulting HI calculated was found to be below 1, and the cancer risk was found to be either less than, or within the risk management range of, 1.0E-06 to 1.0E-04. The actual calculated risks were school site worker (4.0E-06) and school site student (6.0E-07).

Because HIs and cancer risks calculated in the Newfields (2000) HHRA were within or below the risk management range, it was concluded that "there is no scientific basis for restricting either the potential non-potable beneficial uses of the groundwater at the site or the proposal for placement of a school near the site as an acceptable land-use option."

1.6 ECOLOGICAL RISK ASSESSMENT

Several ecological risk assessments (ERA) were conducted to determine whether contaminants in soil or groundwater at Alameda Facility/Alameda Annex and at Alameda Point are causing adverse ecological impacts to the environment. The ERAs are discussed in Sections 1.6.1 and 1.6.2.

1.6.1 Alameda Facility/Alameda Annex Ecological Risk Assessments

The Navy conducted a qualitative ERA of terrestrial habitat at Alameda Facility/Alameda Annex and a quantitative ERA to evaluate impacts of stormwater discharge on Oakland Inner Harbor sediment. The terrestrial ERA found no potential risks to terrestrial receptors, because Alameda Facility/Alameda Annex has (1) limited and unsuitable habitat, (2) no endangered species that feed or nest on the facility, (3) a scarcity of mammalian receptors, and (4) contaminants found in deep soil (the marsh crust) have limited potential for adverse effects to terrestrial biota. Further, terrestrial ecological receptors are not expected to come in contact with groundwater.

The quantitative ERA (TtEMI 1998a) concluded that storm discharges to sediments pose no ecological risk. Sediment bioassay results indicated no significant ecological effects above those found for the rest of the San Francisco Bay. The sediment at outfall 1 appears to pose minimal, if any, ecological hazard given (1) the relatively small area adjacent to outfall 1, (2) the generally degraded habitat under the pier, (3) the fact that no ecological effects were observed, (4) the low apparent bioavailability of chemicals in sediments, and (5) bioassay results comparable to those from other locations in central San Francisco Bay.

Modeling of groundwater transport to the Oakland Inner Harbor was conducted to determine whether the TPH contaminants found in groundwater on the site could present a risk to ecological receptors in the

Oakland Inner Harbor (TtEMI 1998c). The area considered by the model included all of Alameda Facility/Alameda Annex and portions of Alameda Point housing that share borders with Alameda Facility/Alameda Annex (see Figure 1-3). Base-wide groundwater modeling was conducted by modeling the transport of one indicator contaminant, benzene. It was determined that benzene is the most soluble (and thus mobile) of the groundwater contaminants as well as the most toxic. SVOCs, including the PAHs found in the former subtidal area and marsh crust are relatively insoluble and immobile. The modeling determined that benzene plumes will not migrate beyond the boundaries of Alameda Facility/Alameda Annex or Alameda Point. Because benzene was shown not to pose an unacceptable ecological risk, the technical memorandum about the modeling concluded that the other less soluble and less toxic contaminants did not pose unacceptable risks (TtEMI 1998c).

1.6.2 Alameda Point

ERAs have been performed for OU-1(TtEMI 1999a), OU-2 (pending), and OU-3 (TtEMI 1999c); however, ERA results are not discussed further because the former subtidal area and marsh crust are at a depth that precludes a completed exposure pathway for ecological receptors.

2.0 IDENTIFICATION AND DEVELOPMENT OF REMEDIAL ALTERNATIVES

The principal objective of this FS is to develop and evaluate a limited number of remedial alternatives for contamination in the marsh crust at Alameda Facility/Alameda Annex, the subtidal area and marsh crust at Alameda Point, and groundwater at Alameda Facility/Alameda Annex that are consistent with the NCP and CERCLA. The Navy has prepared the FS in accordance with EPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (EPA 1988) and with the understanding of the regulatory agencies that this FS will address the following alternatives:

- The former subtidal area (Alameda Point) and marsh crust at both facilities: (1) no action, (2) institutional controls, (3) excavation and off-site disposal, and (4) excavation and on-site treatment with thermal desorption
- Groundwater at Alameda Facility/Alameda Annex only: (1) no action and (2) institutional controls and groundwater monitoring

As explained in Section 1.1, the FS does not include detailed development of GRA or detailed screening of alternatives that are typically contained in an FS. This streamlined approach is consistent with EPA management principles defined in the NCP. The NCP, 40 CFR Subsection 300.430(a), provides that "site-specific data needs, the evaluation of alternatives, and the documentation of the selected remedy should reflect the scope and complexity of the site problems."

This chapter identifies RAOs for the former subtidal area and marsh crust at Alameda Point and the marsh crust and groundwater at Alameda Facility/Alameda Annex, discusses applicable or relevant and appropriate requirements (ARAR), presents a limited number of GRAs that will protect human health and the environment, and identifies remedial alternatives for the former subtidal area, marsh crust, and groundwater.

2.1 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

RAOs are either medium-specific or OU-specific goals for protecting human health and the environment. Where possible, each RAO should specify (1) each contaminant of concern, (2) the exposure route and each receptor, and (3) an acceptable contaminant concentration or range of concentrations for each exposure pathway and media. No unacceptable risks were identified in the RIs for either facility because no complete exposure pathway is currently present. However, although currently no complete exposure pathway is present to the subtidal area and marsh crust contamination, unacceptable risk is possible if the soil were brought to the surface where it could remain as a source of exposure. In addition although currently no complete exposure pathway is present to the groundwater contamination at Alameda Facility/Alameda Annex, unacceptable risk is possible if accidental ingestion by humans were to occur for an extended period or if ingestion were to result from well construction inconsistent with current well construction regulations. This FS is being prepared to address agency concerns about these potential future risks. RAOs developed for the facilities address limited exposure routes to potential receptors.

2.1.1 Remedial Action Objectives for the Former Subtidal Area and Marsh Crust

This FS is based on the possibility that future construction could bring contaminated material from the former subtidal area and marsh crust to the surface. An NCP remedy is required to address contamination found in the marsh crust and former subtidal area underlying the Alameda Facility/Alameda Annex and Alameda Point to prevent potential future exposure due to uncontrolled placement of marsh crust and former subtidal sediment at the surface where they may pose an unacceptable risk to human health and the environment. As a basis for this FS, the RAO for the former subtidal area and marsh crust is as follows: restrict excavation into the former subtidal area and marsh crust unless proper health and safety (H&S) and disposal procedures are followed.

2.1.2 Remedial Action Objectives for Unanticipated Groundwater Use at Alameda Facility/Alameda Annex

In the RI, no further action was deemed necessary to address groundwater under the NCP because contaminants found in the groundwater underlying the Alameda Facility/Alameda Annex were found to pose no current or likely future risk to human health or the environment. Since completion of the RI, however, the possibility of unacceptable risk from groundwater contamination has been determined if accidental ingestion by humans were to occur for an extended period or if ingestion were to result from well construction inconsistent with current well construction regulations. This FS is based on the premise that the shallow groundwater at Alameda Facility/Alameda Annex would be used for agricultural or industrial purposes despite its low suitability for such uses. Under this scenario, the RAO developed is to restrict human use of, or contact with, the shallow groundwater for consumption or other beneficial uses such as freshwater replenishment.

2.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121 of CERCLA requires that the selected remedy meet ARARs unless a waiver is justified. EPA has identified three classifications of ARARs: chemical-specific, action-specific, and location-specific. During the RIs for both facilities, federal regulatory statutes were evaluated to identify potential federal ARARs, and the State of California was solicited to provide state ARARs. The ARARs selection process is described in the rest of this section, and the resulting ARARs are described in Sections 2.2.1 through 2.2.3.

Alameda Facility/Alameda Annex

In accordance with the NCP (40 CFR 300.515[h][2]), the Navy requested state agencies to provide relevant state ARARs for Alameda Facility/Alameda Annex. The Navy requested ARARs from DTSC in writing on July 6, 1994, and June 19, 1995. DTSC responded to the Navy in writing on August 29, 1995. On July 9,1998, DTSC requested additional ARARs from several state agencies, and these agencies responded in late-July 1998.

Alameda Point

In accordance with the NCP (40 CFR 300.515[h][2]), the Navy has solicited DTSC for timely identification of potential state chemical- and location-specific ARARs for Alameda Point (Navy 1994, 1995, 1996). On November 13, 1996, DTSC responded by letter with a general list of laws they consider as ARARs.

2.2.1 Chemical-Specific Applicable or Relevant and Appropriate Requirements

Chemical-specific ARARs are health- or risk-based numerical standards that, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment to protect against unacceptable risks to human health and the environment.

The Navy has reviewed potential federal and state ARARs and determined that no chemical-specific ARARs apply because the shallow groundwater has no existing or potential beneficial use as domestic or municipal water supply or freshwater replenishment and has limited agricultural and industrial uses. As for the former subtidal area and marsh crust, the Navy has determined that there are no federal or state chemical-specific ARARs.

2.2.2 Location-Specific Applicable or Relevant and Appropriate Requirements

Location-specific ARARs are restrictions placed on the concentrations of hazardous substances or on the conduct of activities due to the characteristics of the site or its immediate environment. For example, location of the site or proposed remedial action in a flood plain, wetland, historic place, or sensitive ecosystem may trigger location-specific ARARs. Any remedial action that would affect a site must comply with these requirements. The Navy has reviewed potential federal and state ARARs and identified the following location-specific ARARs pertaining to remedial alternatives for the former subtidal area, marsh crust, and groundwater.

2.2.2.1 Coastal Zone Management Act

The Coastal Zone Management Act (16 U.S. Code Section 1451) defines activities that affect land or water use in coastal zones, and Section 1456(c) specifies that federal activities that may affect the coastal zone must be consistent, to the maximum extent practicable, with approved state management programs. Within the San Francisco Bay Area, the local coastal zone management program is described in the San Francisco Bay Conservation and Development Commission (SFBCDC) (1998) Bay plan, enacted pursuant to the McAteer-Petris Act of 1965. These requirements are cited in Table 2-1.

2.2.2.2 Protection of Wildlife

Substantive requirements of the California Fish and Game (CFG) code (CFG Section 5650) are included as ARARs because fish and birds use the Oakland Inner Harbor. This requirement is cited in Table 2-1.

2.2.3 Action-Specific Applicable or Relevant and Appropriate Requirements

Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes or substances. These requirements are triggered by the particular remedial activities selected. Action-specific ARARs are discussed in Chapter 3 in conjunction with the specific remedial alternatives to be analyzed.

2.3 GENERAL RESPONSE ACTIONS

GRAs are broad classes of actions that will satisfy RAOs for the site. Based on EPA guidance (1988), GRA categories may include treatment, containment, excavation, extraction, disposal, institutional actions, or a combination of the actions. However, considering the streamlined nature of this FS and the need for action only to minimize the unlikely event of human exposure to the former subtidal area and marsh crust and contaminated groundwater, the GRAs are limited to the following actions:

(1) For the former subtidal area and marsh crust, no action, institutional controls, removal and disposal, and on-site treatment

(2) For groundwater at Alameda Facility/Alameda Annex, no action and institutional controls

The following sections discuss each GRA and its applicability to the former subtidal area and marsh crust at both facilities and to the groundwater at Alameda Facility/Alameda Annex.

2.3.1 No Action

No action implies that no remedial action will be conducted on site. The site is allowed to continue in its current state, and no actions are conducted to remove or contain the residual former subtidal area and marsh crust or groundwater contamination. No additional access restrictions would be put into place, and no institutional controls would be placed on the site. The NCP requires inclusion of the no action response among the alternatives evaluated in every FS (40 CFR Subsection 300.430[e][6]). The no action response provides a baseline for comparison to the other remedial response actions.

2.3.2 Institutional Controls

Institutional controls as defined by the Navy in an interim final memorandum (Chief of Naval Operations 1999) are non-engineering measures limiting potential exposures to a site or media of concern or ensuring that engineering measures designed to remediate a site or limit access remain in place. The EPA defines institutional controls as "..non-engineering measures designed to prevent or limit exposure to hazardous substances left in place at a site, or assure effectiveness of a selected remedy. Institutional controls are usually, but not always, legal controls such as easements or restrictive covenants". Examples of institutional controls cited include easements, covenants, equitable servitudes, notices (in the deed or in local newspapers), zoning, educational materials, permits (such as construction, well drilling, and excavation permits), and agreements with regulators. At the request of DTSC and EPA, this FS will consider an institutional control alternative that is a land use covenant in which the DTSC enforces appropriate land use restrictions.

2.3.3 Removal and Off-Site Disposal

This GRA involves the physical removal of the former subtidal area and marsh crust from the site. Removal of contaminated former subtidal area and marsh crust using mechanical excavation is an action that removes the source of contamination. The material removed from the former subtidal area and marsh crust could be transferred to a municipal or Resource Conservation and Recovery Act (RCRA) landfill, where it would be contained in cells designed to reduce mobility. Removal may also be followed by treatment prior to off-site disposal.

2.3.4 On-Site Treatment

On-site treatment implies that the former subtidal area and marsh crust will be excavated and treated on site using aboveground treatment technologies and process options and would then be used as backfill on the site. These actions include the use of physical, chemical, thermal, and biological processes for treating soil above ground to provide a significant reduction of the toxicity, mobility, or volume of waste. Many treatment actions will generate residual material or by-products that undergo disposal with or without further treatment. The residuals or by-products may be hazardous and would be disposed of off-site using an appropriate treatment or land disposal facility.

2.4 CONTAMINATED SOIL VOLUME ESTIMATES

For those GRAs that require excavation of former subtidal area and marsh crust for treatment or disposal, either on site or off site, the volume of material to be excavated is estimated to assist in evaluating the alternatives. The volume of contaminated material composing the former subtidal area and marsh crust was based on the following assumptions:

- The entire 143-acre Alameda Facility/Alameda Annex is built on top of a former tidal marsh and tidal channels (Figure 1-3). An additional 584 acres of Alameda Point is built on top of another part the tidal marsh and on a subtidal area at a depth of negative 1 foot MLLW (Figure 1-6). A layer of contaminated subtidal area and marsh crust is still present at the depth of the former marsh surface or channel bottom and former subtidal area.

- At Alameda Facility/Alameda Annex, the average thickness of the fill soil over the marsh crust was found to be 15.3 feet. At Alameda Point, the average thickness of the fill soil over the former subtidal area and marsh crust was found to be 8 feet. It is assumed that the fill soil will be excavated as clean overburden to a depth of 15 feet at Alameda Facility/Alameda Annex and a depth of 8 feet at Alameda Point and that a layer of contaminated soil and marsh crust with an average thickness of 1.5 feet will be removed. The overburden will be returned to the site as fill. Contaminated soil removed will either be treated on site and returned as clean fill or will be taken off site for disposal. If contaminated soil is disposed off site, 1.5 feet of clean fill will be brought in to replace it.
- A 30 percent swell factor on excavation is assumed for the overburden and the soil removed with the former subtidal area and marsh crust.

Based on the above assumptions, the total quantity of contaminated soil to undergo treatment or disposal is calculated as follows:

Alameda Facility/Alameda Annex

- 1 acre (Ac) x 43,560 square feet (ft^2)/Ac = 43,560 ft^2/Ac
- 43,560 ft^2/Ac x 1.5-foot (ft)-thick layer = 65,340 cubic feet (ft^3)/Ac
- 65,340 ft^3/Ac + 30% swell = 84,942 ft^3/Ac
- 84,942 ft^3/Ac ÷ 27 ft^3/ cubic yards (yd^3) = 3,146 yd^3/Ac
- 3,146 yd^3/Ac x 143 Ac = 449,878 yd^3

Alameda Point

- 1 Ac x 43,560 ft^2/Ac = 43,560 ft^2/Ac
- 43,560 ft^2/Ac x 1.5-ft-thick layer = 65,340 ft^3/Ac
- 65,340 ft^3/Ac + 30% swell = 84,942 ft^3/Ac
- 84,942 ft^3/Ac ÷ 27 ft^3/yd^3 = 3,146 yd^3/Ac
- 3,146 yd^3/Ac x 584 Ac = 1,837,264 yd^3

As a result, the volume of contaminated soil is estimated to be 2,287,142 yd^3.

2.5 REMEDIAL ALTERNATIVE DEVELOPMENT

As set forth in Section 2.1, RAOs are defined as (1) to limit ingestion of, direct contact with, or inhalation of PAHs from the former subtidal area and marsh crust by future site occupants and (2) to restrict human use of, or contact with, the shallow groundwater for consumption or other beneficial uses such as freshwater replenishment at the Alameda Facility/Alameda Annex.

In keeping with the streamlined approach for this FS, a one-step process has been used to identify remedial alternatives for the former subtidal area, marsh crust, and groundwater. These remedial alternatives have been developed to comply with the NCP and to satisfy RAOs developed for the former subtidal area and marsh crust at both facilities and groundwater at the Alameda Facility/Alameda Annex. The identified remedial alternatives are described separately for the former subtidal area and marsh crust and groundwater in the following sections.

2.5.1 Former Subtidal Area and Marsh Crust Alternatives

The following four alternatives are identified for the remediation of the former subtidal area and marsh crust at the Alameda Facility/Alameda Annex:

Alternative 1 – No Action

Alternative 2 – Institutional Controls

Alternative 3 – Excavation and Off-Site Disposal

Alternative 4 – Excavation and On-Site Treatment with Thermal Desorption

Each of these alternatives is described in the following sections.

2.5.1.1 Alternative 1 (Former Subtidal Area and Marsh Crust) – No Action

No remedial action would be taken under Alternative 1. Existing conditions in the former subtidal area and marsh crust would remain the same.

The no action alternative would rely upon no supplemental institutional control, containment, removal, or treatment to restrict risk to human health and the environment that may result from the former subtidal area and marsh crust at Alameda Facility/Alameda Annex or Alameda Point. The no action alternative is retained throughout the FS process, as required by the NCP, to provide a comparative baseline against which other alternatives can be evaluated.

2.5.1.2 Alternative 2 (Former Subtidal Area and Marsh Crust) – Institutional Controls

Under Subtidal Area and Marsh Crust Alternative 2, and Groundwater Alternative 2, institutional controls will be implemented to restrict site occupants from excavating into the marsh crust or from extracting groundwater without obtaining the required permits and taking proper measures to dispose of extracted soil or groundwater and ensure that no groundwater is consumed. A summary of the covenant is as follows:

The following activities are prohibited on the property:

(1) Construction of any water well screened for the extraction of water from the shallowest groundwater zone except as provided in this covenant

(2) Extraction (except for necessary construction site dewatering), use, or consumption of water from the shallowest groundwater zone for use other than irrigation or emergency use such as. firefighting

(3) Disposal of extracted groundwater from construction site dewatering into the waters of the state except in compliance with the requirements of the RWQCB

(4) Engaging in any excavation below the threshold depth without a City excavation permit. If the excavation ordinance has been repealed, or if DTSC has made a written determination with 30 days prior written notice to the City that the excavation ordinance does not comport with the intent of this covenant, then a permitted excavation may be conducted only in accordance with a written approval issued by DTSC. Covenantor's application for such an approval shall be submitted to DTSC and shall otherwise comply with the permit application requirements of the last version of the excavation ordinance or such other requirements as DTSC may specify.

2.5.1.3 Alternative 3 (Former Subtidal Area and Marsh Crust) – Excavation and Off-Site Disposal

The implementation of this alternative involves excavation and transport of contaminated former subtidal area and marsh crust underlying the entire facility for off-site disposal in a Class I, Class II, or municipal landfill, depending on the appropriate waste classification. The former subtidal area and marsh crust would be identified using a cleanup level established for the soil that is protective for future exposures due to construction activities. This cleanup level was not developed as part of the FS, but it is assumed that the chemicals in the former subtidal area and marsh crust are contained within a layer of surrounding soil 1.5 feet thick. The volume involved would be extremely large because it would consist of excavating the entire surface area of Alameda Facility/Alameda Annex to an average depth of 16.5 feet and 548 acres of Alameda Point to an average depth of 9.5 feet, approximately 1.5 feet below the average depth of the former subtidal area and marsh crust. Excavation can be achieved by mechanical methods using conventional excavation equipment such as scrapers, drag lines, dump trucks, and bulldozers. Special equipment may be needed during excavation operations because of complex site conditions such as groundwater, saltwater intrusion, depth of former subtidal area and marsh crust, and tidal effects. Site preparation activities, such as clearing utilities, constructing runon and runoff controls, and demolishing buildings, would be conducted before excavation. Shoring would be provided when the depth of excavation exceeds 5 feet bgs. A dewatering pumping system would be installed to remove water from excavation pits. Contaminated water generated during excavation operations would be treated on site using a granular-activated carbon (GAC) process and would be discharged into the sanitary sewer. Spent GAC would be transported off site for contaminant destruction and GAC regeneration at an approved facility.

Clean soil and overburden and contaminated former subtidal area and marsh crust would be stockpiled separately at the site before disposal or treatment. Stockpile management areas would be set up as needed. The amount of soil that would require off-site disposal in a Class I or II landfill is about 2,287,142 yd^3. After excavation, soil will be sampled from the stockpile and compared to federal and state hazardous waste criteria to determine its appropriate waste classification. The soil will also be evaluated to determine if treatment is required prior to land disposal. After the soil is excavated, loaded, and hauled away, excavation areas will be backfilled using clean overburden and replacement fill and regraded to original condition.

A detailed discussion of this alternative is provided in Chapter 3.

2.5.1.4 Alternative 4 (Former Subtidal Area and Marsh Crust) – Excavation and On-Site Treatment with Thermal Desorption

Under this alternative, the former subtidal area and marsh crust would be excavated as described in Section 2.5.1.3 and treated on site using a thermal desorption unit sufficient to volatilize contaminants, but not to destroy the contaminants. VOCs in the off-gas stream would be treated on site using an afterburner gas treatment system. Specific actions include excavation, on-site treatment using a thermal desorption process, and backfilling of excavated areas with clean overburden and treated soil. For thermal desorption, a vendor would mobilize a thermal desorption unit to the site and set it up in a predetermined location. Auxiliary equipment, including a loader, crusher, screening plant, and feed belt conveyor, would also be provided. A cleanup level would be established for treated soil that is protective for future exposures due to construction activities. This cleanup level was not developed as part of the FS.

Thermal desorption is a process that uses either an indirect or direct heat exchange to heat organic contaminants to a temperature high enough to volatilize and separate them from contaminated soil. Contaminated soil is excavated and delivered to the thermal desorption unit. In the desorption unit, heat is transferred to the soil. Contaminated soil is heated, and water and contaminants are volatilized. An inert gas, such as nitrogen, or an oxygen-deficient (less than 4 percent) combustion off-gas is used as the transfer medium for vaporized components. SVOCs and VOCs in the off-gas are burned in an afterburner under this alternative.

Operation of a thermal desorption system can create a number of residual streams: treated soil; untreated, oversized rejects; condensed contaminants and water; particulate control system dust; clean off-gas; and spent carbon, if used. Treated soil, debris, and oversized rejects are suitable for return on site after demonstrating that they do not pose risk to human health or the environment. System performance is typically measured by comparison of untreated soil contaminant levels with those of processed soil.

A detailed description of this alternative is provided in Chapter 3.

2.5.2 Groundwater Alternatives

The following two alternatives are identified for groundwater at the Alameda Facility/Alameda Annex:

- Alternative 1 – No Action
- Alternative 2 – Institutional Controls and Groundwater Monitoring

Because groundwater at the Alameda Facility/Alameda Annex is not potable and has limited other beneficial uses (such as agricultural and industrial uses), no other alternatives (such as containment, extraction, treatment, and disposal alternatives) were considered for groundwater.

Each of the alternatives for groundwater is described as follows.

2.5.2.1 Alternative 1 (Groundwater) – No Action

No remedial action would be taken under Alternative 1. Existing site conditions would remain in place. No institutional control, containment, removal, or treatment would be implemented, and no other mitigating actions would be taken at Alameda Facility/Alameda Annex. The no action alternative is retained throughout the FS process, as required by the NCP, to provide a comparative baseline against which other alternatives can be evaluated.

2.5.2.2 Alternative 2 (Shallow Groundwater) – Institutional Controls and Groundwater Monitoring

Under Subtidal Area and Marsh Crust Alternative 2 and Groundwater Alternative 2, institutional controls will be implemented to restrict site occupants from excavating into the marsh crust or from extracting groundwater without obtaining the required permits and taking proper measures to dispose of extracted soil or groundwater and ensure that no groundwater is consumed. A summary of the covenant is as follows:

The following activities are prohibited on the property:

(1) Construction of any water well screened for the extraction of water from the shallowest groundwater zone except as provided in this covenant

(2) Extraction (except for necessary construction site dewatering), use, or consumption of water from the shallowest groundwater zone for use other than irrigation or emergency use firefighting

(3) Disposal of extracted groundwater from construction site dewatering into the waters of the state except in compliance with the requirements of the RWQCB

(4) Engaging in any excavation below the threshold depth without a City excavation permit. If the excavation ordinance has been repealed or if DTSC has made a written determination with 30 days prior written notice to the City that the excavation ordinance does not comport with the intent of this covenant, then a permitted excavation may be conducted only in accordance with a written approval issued by DTSC. Covenantor's application for such an approval shall be submitted to DTSC and shall otherwise comply with the permit application requirements of the last version of the excavation ordinance or such other requirements as DTSC may specify

In addition to the above covenant, groundwater monitoring will be conducted by the Navy to demonstrate that contaminated groundwater is not migrating off the site at levels that could cause unacceptable risk to human health or the environment.

3.0 DETAILED ANALYSIS OF ALTERNATIVES

Alternatives identified in Chapter 2 for marsh crust and the former subtidal area at Alameda Facility/Alameda Annex and Alameda Point and shallow groundwater at Alameda Facility/Alameda Annex are evaluated in this chapter in detail to provide sufficient information to compare the alternatives, select an appropriate remedy, and demonstrate satisfaction of CERCLA remedy selection requirements in a record of decision (ROD). Although the evaluation has been streamlined for the purpose of this FS, the evaluation was performed in accordance with CERCLA as amended by the Superfund Amendments and Reauthorization Act (SARA) and the NCP. The detailed analysis of alternatives consists of the following components:

- Evaluation criteria (Section 3.1)
- Individual analysis of alternatives (Section 3.2)
- Comparative analysis of alternatives (Section 3.3)

3.1 EVALUATION CRITERIA

The detailed analysis of alternatives is based on the nine evaluation criteria specified by the NCP (40 CFR section 300.430(e)(a)(iii)) and the guidance for conducting RIs and FSs under CERCLA (EPA 1988). The nine evaluation criteria are described as follows:

- **Overall protection of human health and the environment.** This criterion describes the way that each alternative as a whole protects human health and the environment. The criterion focuses on a specific alternative's ability to achieve adequate protection and describes the way site risks passed through each pathway are eliminated, reduced, or controlled through treatment, engineering, or institutional controls. This evaluation also allows for consideration of any unacceptable short-term or cross-media impacts associated with each alternative.

- **Compliance with ARARs.** This criterion evaluates each alternative's compliance with federal and state ARARs and "to be considered" requirements. If an ARAR waiver is required, this criterion evaluates the approach taken to justify the waiver. ARARs address location-specific, chemical-specific, and action-specific concerns.

- **Long-term effectiveness and permanence.** This criterion addresses the risk remaining at the site after RAOs have been met. The primary focus of this evaluation criterion is the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and untreated wastes. Factors considered include the magnitude of residual risks and adequacy and reliability of release controls.

- **Reduction of toxicity, mobility, or volume through treatment.** This criterion addresses the statutory preference for remedial alternatives that employ treatment technologies for permanent and significant reduction of toxicity, mobility, and volume. This criterion focuses on (1) treatment processes and materials treated; (2) amount of hazardous materials that will be destroyed or treated; (3) degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction (or order of magnitude); (4) degree to which the treatment will be irreversible; (5) type and quantity of treatment residuals that will remain following treatment; and (6) ability of the alternative to satisfy the statutory preference for treatment as a principal element.

- **Short-term effectiveness.** This criterion examines the effectiveness of each alternative in protecting human health and the environment during the construction and implementation period until the RAOs are met. Four factors are considered when assessing the short-term effectiveness of an alternative: protection of the community during remedial actions, protection of workers during remedial actions, environmental impacts of remedial actions, and time required to complete the remedial action to achieve the RAOs.

- **Implementability.** This criterion evaluates the technical and administrative feasibility of each alternative and the availability of various services and materials required during its implementation.

- **Cost.** This criterion addresses capital costs, both direct and indirect; annual operation and maintenance (O&M) costs; accuracy of the cost estimate; present worth analysis; and cost-sensitivity analysis of alternatives. Cost estimates for alternatives were prepared from cost information included in (1) environmental cost handling options and solutions (R.S. Means and Delta Technologies Group Inc. 1997), (2) Means Heavy Construction Cost Data (R.S. Means 1997), (3) remedial action cost engineering and requirements system (Delta Technologies Group, Inc. 1997), and (4) CostPro closure and post-closure estimating software users manual (TtEMI 1997). Capital and O&M cost estimates are order-of-magnitude level estimates and have an expected accuracy of minus 30 to plus 50 percent.

- **State acceptance.** This criterion evaluates technical and administrative issues and concerns that the state may have regarding each of the alternatives. This criterion is not addressed in this FS report but will be addressed in the ROD after comments are received from the state.

- **Community acceptance.** This criterion evaluates the issues and concerns that the public may have regarding each of the alternatives. This criterion is not addressed in this FS report but will be addressed in the ROD after public comments have been received on the proposed plan.

The first two criteria are categorized as threshold criteria; they relate directly to statutory requirements that each remedial alternative must meet. If a given alternative does not satisfy both of these criteria, then it is not retained for further consideration beyond the individual analysis of alternatives. The next five are the primary balancing criteria upon which the selection of the remedy is based. Together, these first seven criteria are considered to be the evaluation criteria; the final two are modifying criteria.

In the following sections, each alternative is described, assessed against the seven evaluation criteria, and comparatively analyzed to assess the relative performance of each alternative with respect to these criteria. The remaining two criteria, the modifying criteria, will be addressed in the ROD when comments are received from the state and public on the proposed plan.

3.2 DETAILED INDIVIDUAL ANALYSIS OF ALTERNATIVES

This section describes in detail each of the four former subtidal area and marsh crust alternatives and the two groundwater alternatives developed in Section 2.5 and evaluates each alternative against the seven evaluation criteria discussed in Section 3.1.

3.2.1 Former Subtidal Area and Marsh Crust Alternatives

This section describes in detail each of the four alternatives developed in Chapter 2 for the former subtidal area and marsh crust and evaluates the alternatives against the seven CERCLA evaluation criteria.

3.2.1.1 Alternative 1 - No Action

No remedial action would be taken under Alternative 1. The physical condition of the former subtidal area and marsh crust would remain unchanged. No institutional controls, containment, removal, or treatment would be implemented, and no other mitigating actions would be taken. Alternative 1 is retained throughout the FS process, as required by the NCP, to provide a comparative baseline against which other alternatives can be evaluated.

Overall Protection of Human Health and the Environment

Currently, no risk to human health or the environment is present from the former subtidal area and marsh crust at Alameda Facility/Alameda Annex because no exposure pathway is present. The marsh crust at Alameda Facility/Alameda Annex is currently isolated from human and ecological receptors because it is inaccessible, under an average of 15.3-foot-thick layer of fill material. The former subtidal area and marsh crust at Alameda Point is also inaccessible to future residents; although it is found under a layer of only 4 to 10 feet of fill material and is therefore accessible to construction workers. Despite this exposure, the risk is acceptable as stated in the OU-1 RI (TtEMI 1999a), the pending OU-2 RI, and the OU-3 RI (TtEMI 1999c). Although currently no complete exposure pathway for residents is present to the subtidal area and marsh crust contamination, unacceptable risk to residents is possible if the soil were brought to the surface where it could remain as a source of exposure. Because of this concern, Alternative 1 may not be protective of human health and the environment.

Compliance with ARARs

No ARARs would apply to Alternative 1 for the marsh crust.

Long-Term Effectiveness and Permanence

At Alameda Facility/Alameda Annex, existing marsh crust contamination currently poses no unacceptable risks to human health because there is currently no exposure pathway. Under likely future scenarios, the 15.3-foot-thick layer of fill would continue to cover marsh crust at Alameda Facility/Alameda Annex and would be unlikely to be removed or eroded. The former subtidal area and marsh crust at Alameda Point would remain inaccessible to future residents under the current scenarios, and although it would be accessible to construction workers, the risk would be acceptable. Although currently no complete exposure pathway is present to the subtidal area and marsh crust contamination other than for construction workers at Alameda Point, unacceptable risk would be possible if the soil were brought to the surface where it could remain as a source of exposure. Because of the possibility of exposure to contaminants from the former subtidal area and marsh crust brought to the surface during construction activities, Alternative 1 may not be effective over the long term.

Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would not reduce the toxicity, mobility, or volume of contaminants in the former subtidal area and marsh crust because contaminated former subtidal area and marsh crust would not be treated, contained, or removed. Alternative 1 for the former subtidal area and marsh crust would, therefore, not satisfy this criterion because no treatment is involved.

Short-Term Effectiveness

This criterion examines the effectiveness of the alternative during construction and implementation of the remedy until the RAO is met. No remedial action is involved under Alternative 1, so no new health risks are posed to the community, current occupants, workers or the environment in the short term. Alternative 1 is, therefore, considered to be highly effective in the short term.

Implementability

Because Alternative 1 involves no action, there are no technical administrative difficulties involved with implementing this alternative. Therefore, implementability of this alternative is considered to be high.

Cost

No capital or O&M costs are associated with Alternative 1.

3.2.1.2 Alternative 2 - Institutional Controls

Alternative 2, institutional controls, involves the DTSC entering into a land use covenant. No active engineering or construction would be required. The institutional controls would restrict excavation in the former subtidal area and marsh crust unless proper health and safety and disposal procedures are followed. The institutional controls would be enforceable by the DTSC.

Overall Protection of Human Health and the Environment

The risk to human health or the environment from the subtidal area and marsh crust at Alameda Facility/Alameda Annex and Alameda Point is currently below the EPA risk management range. However, future excavation activities could bring material to the surface where it could remain as a source of exposure and could pose an unacceptable risk to human health and the environment. The institutional controls would regulate disposal of the former subtidal area and marsh crust and would implement an enforcement mechanism through DTSC. Human health and the environment would be protected by requiring that workers handle and dispose of excavated soil in a way that prevents exposure.

Because institutional controls would reduce the already low likelihood of exposure to the former subtidal area and marsh crust, Alternative 2 is protective of human health and the environment.

Compliance with ARARs

No ARARs would apply to Alternative 2 for the former subtidal area and marsh crust.

Long-Term Effectiveness and Permanence

Alternative 2 would be effective in the long term because its implementation would become part of the DTSC's ongoing governmental oversight role. Also, the land use covenant would be in chain of title which would put all future owners on notice. This type of covenant has more "permanence" than government controls. Because the institutional controls would reduce the possibility that future occupants would excavate the former subtidal area and marsh crust without taking proper precautions, this alternative would be effective over the long term.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 2 would not reduce the toxicity, mobility, or volume of contaminants in the former subtidal area and marsh crust because contaminated material would not be treated, contained, or removed. Institutional Control Alternative for the former subtidal area and marsh crust would not, therefore, satisfy this criterion because no treatment is involved. For this reason, the effectiveness of this alternative in reducing toxicity, mobility, or volume would be low.

Short-Term Effectiveness

This criterion examines the effectiveness of the alternative during construction and implementation of the remedy until the RAO is met. Because Alternative 2 would involve no remedial action or construction, no new short-term health risks are caused to the community, current occupants, workers, or the environment. The institutional controls could be implemented within a short period of time. Alternative 2 would, therefore, be highly effective in the short term.

Implementability

No construction would be required to implement Alternative 2. The only administrative consideration is that the excavation ordinance would have to be negotiated and signed by DTSC. Legal services to implement this alternative are available to DTSC; therefore, Alternative 2 would be readily implementable.

Cost

No known capital or O&M costs would be associated with Alternative 2; however, some costs would be associated with the administrative effort to negotiate the land use covenant, and monitor compliance with these requirements. The costs are estimated at approximately $48,720 for each facility (Appendix A). These costs are for 5-year reviews to ensure long-term compliance with this alternative (for a period of 30 years) and other costs associated with implementing and monitoring the institutional controls.

3.2.1.3 Alternative 3 - Excavation and Off-Site Disposal

Although site risks are currently below the risk management range, Alternative 3, excavation and off-site disposal, would involve excavation and off-site disposal of former subtidal area and marsh crust at a Class I or II landfill. Excavation would involve preparing the site; dividing the site into several areas that can be accessed by the construction equipment; excavating and stockpiling the overburden, excavating the former subtidal area and marsh crust, confirmation sampling to show that the former subtidal area and marsh crust has been sufficiently removed, and backfilling and restoring excavated areas with overburden and clean fill. The average anticipated excavation depth would be approximately 16.8 feet bgs at Alameda Facility/Alameda Annex and 9.5 feet at Alameda Point.

The excavation approach would be described in a remedial action plan that would discuss excavation methods, environmental impact assessment, health and safety monitoring, runon and runoff controls, soil sampling and analysis, and soil removal. Preparation of a detailed operational sequence for Alternative 3 is not within the scope of this FS; however, a discussion of general activities that would be conducted under Alternative 3 follows.

Site Preparation

Equipment and personnel would be mobilized at the site, and the site would be prepared for excavation and staging. Site preparation activities would include clearing and removing vegetation; constructing runon and runoff controls for surface drainage control; constructing decontamination facilities; demolishing buildings; removing concrete aprons and asphalt pavement; removing bins; relocating utilities; and removing railroad spurs and fences, as necessary. Site preparation work also would include setting up on-site staging areas and constructing a temporary chain-link fence, with gates around the proposed excavation area to prevent unauthorized access to the work area. Excavation areas would be surveyed and field-staked by certified land surveyors. Clearance would be required for electrical, gas, sanitary and storm sewer, and water lines.

Runon water would be controlled by constructing berms surrounding excavation areas or diverting runon water from excavation areas. A decontamination area would be constructed to capture all water used to decontaminate excavation equipment and vehicles. The decontamination area would be constructed of a high-density polyethylene liner and bermed.

Excavation and Groundwater Management

Marsh crust is expected to exist throughout all 143 acres of Alameda Facility/Alameda Annex. The former subtidal area and marsh crust is expected to exist throughout approximately 584 acres of Alameda Point. Buildings would be demolished to allow removal of underlying former subtidal area and marsh crust. Building remnants, such as foundations and walls, would be removed using excavation equipment, loaded on dump trucks, covered, and transported to an approved disposal facility. Railroad spurs also would be dismantled and removed before the excavation, as necessary.

The facilities would be divided into multiple excavation areas. Excavation would be conducted in one area, while other areas are being used to stockpile overburden. After the former subtidal area and marsh crust layer has been removed and placed in transport bins, the overburden would be returned and used as backfill. Areas where remediation is completed would be used to place stockpiles from the next area to be excavated. Clean fill and contaminated soil would be excavated mechanically using standard construction equipment such as scrapers, drag lines, dump trucks, and bulldozers. The first 5 feet of soil would be dry and clean and stockpiled separately on site. The next 3 to 10 feet would require excavation with drag lines because the soil is saturated at a depth greater than 5 feet. Sheetpiling would be used as needed to allow dewatering of excavations. An estimated total volume of 22.9 million cubic yards would be generated as clean overburden excavated from these 8 to 15 feet of clean soil (for Alameda Point and Alameda Facility/Alameda Annex respectively). The estimated 1.5-foot-thick layer of soil mixed with former subtidal area and marsh crust would be removed last. The estimated volume of contaminated soil would be about 2,287,142 yd^3. The total average depth of excavation is assumed to be 16.5 feet at Alameda Facility/Alameda Annex and 9.5 feet at Alameda Point. Shoring would be used when the depth of excavation exceeds 5 feet.

Pump and piping systems would be used to remove water encountered during excavation. An estimated 421 million gallons of water would be pumped during excavation operations due in large part to saltwater intrusion during excavation. This water would be treated using GAC units, and the treated water would be discharged to the San Francisco Bay or under permit to EBMUD, the local publicly owned treatment works (POTW). Temporary sheet pile walls would be constructed around excavation areas to prevent or minimize sea water intrusion.

Former subtidal area and marsh crust would be screened visually, and uncontaminated material would be separated from contaminated soil. Dust would be controlled by spraying water on contaminated soil with a mobile water source during excavating, staging, and loading activities. Contaminated material would be transported in covered trucks to a Class I or II landfill. The soil would be characterized to determine the appropriate disposal site. Prior to off-site disposal, contaminated soil will be stockpiled within the area of contamination.

When the excavation is completed, the excavation area would be surveyed and backfilled with overburden or clean fill, after which the area would be compacted. The site then would be restored to surrounding conditions. After backfill and compaction, the remedial action for the site would be complete.

Overall Protection of Human Health and the Environment

Implementation of Alternative 3 may in the long run provide overall protection of human health and the environment. This alternative would permanently eliminate threats to human health by removing the source of the contamination and eliminating potential pathways, resulting in very small residual risks. Even minimal site risks from exposure to the former subtidal area and marsh crust would be removed. Compliance with ARARs during implementation of this alternative will protect human health and the environment. Moving high volumes of soil creates substantial and costly short-term risks to the community, site workers, and the environment. The RAO would be achieved, though only after several years to complete the action.

Excavation and removal would generate an extremely large volume of former subtidal area and marsh crust and groundwater during mass-scale excavation, which would not serve CERCLA's purpose of reducing hazardous wastes. The excavation alternative could also create significant short-term risks to the community, site workers, and the environment. The massive excavation, stockpile, and transportation of an estimated 2,287,142 yd^3 of former subtidal area and marsh crust would require approximately 114,357 truck trips back and forth to the landfill, assuming that each truck holds 20 yd^3. An estimated 421 million gallons of water would be generated, all of which would have to be tested (possibly treated) and discharged appropriately. Workers would be exposed to potential risks from operation of equipment in deep excavations and from handling large volumes of former subtidal area and marsh crust. Residents of the City of Alameda would have to bear the danger and inconvenience of a large increase in truck traffic and a potential increase in health risks from fugitive dust emissions and diesel exhaust, although protective measures would be undertaken during excavation and transport of former subtidal area and marsh crust to mitigate risks to the community. While this alternative would be extremely disruptive in the short term, it would be protective of human health and the environment.

Compliance with ARARs

No chemical-specific ARARs have been identified for Alternative 3.

Alternative 3 would comply with all location- and action-specific ARARs. The location-specific ARARs introduced in Section 2.2.1 apply to Alternative 3. Alameda Facility/Alameda Annex and Alameda Point are not located in the coastal zone; however, excavation and disposal activities will be conducted to the maximum extent practicable, with the San Francisco Bay plan (SFBCDC 1998) because these activities may affect resources of the coastal zone at adjacent facilities. In addition, because birds and fish use the Oakland Inner Harbor, the Navy has identified CFG Section 5650 as relevant and appropriate to Alternative 3. Excavation would be conducted to prevent disposition into the Oakland Inner Harbor of contaminated material that could be deleterious to birds or fish that live there. These location-specific ARARs are listed in Table 2-1.

The Navy's excavation and disposal activities would potentially trigger a variety of hazardous waste requirements under the California Hazardous Waste Control Law (California H&S Code § 25100, and following sections). These requirements determine how excavated soil (the former subtidal area and the marsh crust and overburden) and extracted groundwater must be managed. The Navy would analyze samples from excavated soil and extracted groundwater in accordance with hazardous waste identification regulations in Title 22 of the California Code of Regulations (CCR), Division 4.5, Chapter 11, Articles 2 and 3 to determine whether soil and groundwater exhibit state or federal hazardous waste characteristics. The former subtidal area and the marsh crust soil and other media that qualify as hazardous waste would be managed in accordance with substantive generator requirements in 22 CCR, Division 4.5, Chapter 12, Articles 1 to 3 (22 CCR Section 66262.34). Soil that must be managed as hazardous waste would be stockpiled within the area of contamination so that minimum technology requirements and land disposal restrictions are not triggered. As appropriate, extracted overburden and groundwater would be evaluated in accordance with 22 CCR, Division 4.5, Chapter 18, Article 1 (22 CCR § 66268.7(a)) to determine whether they are subject to land disposal restrictions.

Several Bay Area Air Quality Management District (BAAQMD) regulations are potential ARARs for excavation activities. First, substantive requirements in BAAQMD Regulation 6 and Regulation 8-40 are ARARs for excavation activities. Specifically, Regulations 6-301, 6-302, and 6-305, which contain particulates and visible emissions standards, would be applicable to limit emissions of dust and particulates during excavation and removal of soil. The Navy would take appropriate actions, such as water spraying, to control dust emissions during excavation and transport. Regulation 8-40-301, which limits uncontrolled aeration, and Regulation 8-40-303, which contains requirements for soil storage piles, also would be ARARs for stockpiling of soil.

If the soil must be managed as hazardous waste, the precipitation and drainage requirements for stockpiling of soil in 23 CCR, Division 3, Chapter 15, Section 2546, would be relevant and appropriate to Alternative 3. These action-specific ARARs are listed in Table 3-1.

Because off-site transportation and disposal requirements are not ARARs, both substantive and administrative requirements will be followed.

Alternative 3 would satisfy the criterion of compliance with ARARs.

Long-Term Effectiveness and Permanence

The removal and off-site disposal of the former subtidal area and marsh crust would meet the RAO by eliminating the source of contamination and potential pathways. Residual risks are permanently eliminated by removing the source. Excavation and disposal are proven and reliable technologies that would effectively remove the former subtidal area and the marsh crust and thus permanently reduce the possibility of human exposure to the materials. No long-term management is needed, though monitoring may be required to verify total removal. Alternative 3, therefore, would be highly effective over the long term.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 3 would not reduce the toxicity, mobility, or volume of hazardous substances removed from the site because the former subtidal area and the marsh crust would not be treated, contained, or reduced in volume. Instead, all the former subtidal area and the marsh crust would be unearthed and removed from one location and transported to and deposited at another. Alternative 3 would not satisfy CERCLA's preference for treatment as a principal element or the NCP bias against off-site land disposal of untreated waste (40 CFR 300.430 (f)(1)(ii)(E)). However, principal threats at the site would be reduced by permanently removing the source of contamination. Excavation and off-site disposal would therefore have low effectiveness at satisfying this criterion.

Short-Term Effectiveness

The scale of excavation and disposal operations for the former subtidal area and the marsh crust raise serious questions about the short-term effectiveness of this alternative. As stated above, construction would be disruptive and could create health risks for the community, site workers, and the environment in the short term.

Measures would be taken while excavating, staging, loading, and transporting the former subtidal area and the marsh crust to reduce and control short-term risks to the community. For example, dust suppression measures would be used to reduce generation of fugitive dust. The extent of fugitive dust generation would be monitored to determine that these measures are effective. Furthermore, site access would be controlled to reduce the potential for direct contact with contaminated soil by installation of temporary fences during excavation. Increased truck traffic would be difficult to reroute because routes into Alameda Facility/Alameda Annex and Alameda Point are limited.

Potential hazards to workers would include inhalation of, absorption of, and contact with hazardous substances in contaminated soil. On-site remedial workers would wear personal protective equipment during contaminated soil excavation activities. Air monitoring would be conducted to assist in determining the required level of protection. Potential risk to site workers could be controlled with proper equipment and H&S plans.

Engineering controls would be used to minimize any impacts to the environment. Surface drainage controls and appropriate equipment decontamination procedures would be used to prevent transport of contaminated soil to uncontaminated areas.

According to estimates based on assumptions used in Appendix A, about 2 years would be required to mobilize necessary equipment, excavate the former subtidal area and the marsh crust, transport the soil to a Class I or II landfill, restore the site, and demobilize. An additional 12- to 18-month period would be needed to conduct predesign studies, prepare the remedial design (including all associated plans), and consult with appropriate agencies.

The excavation and disposal alternative would require a highly organized and costly effort to control the short-term impacts to the community, site workers, and the environment. Though measures would be taken to protect human health and the environment, risks presented by emissions of possibly contaminated dust to the community, workers, and the environment would be considerable. Accordingly, Alternative 3 would provide low to moderate effectiveness in the short-term.

Implementability

Alternative 3 would be difficult to implement. Special equipment, shoring, and continuous dewatering would be required during excavation. Infiltration of seawater and tidal fluctuations would make large excavation activities below the groundwater even more difficult. Large quantities of contaminated groundwater would be generated and would probably require treatment before disposal. Additionally, the extent of the former subtidal area and the marsh crust is uncertain, and delineation of it would be difficult below the water table at the proposed excavation depth. Delays would be expected from uncontrolled infiltration of water in excavation pits. The availability and schedule of disposal facilities would also be problematic because of the large volume of soil requiring disposal. General and special earthwork construction equipment would be required for this alternative. Excavation and analytical specialists would be required and would be available. Removal and disposal technologies have been developed and demonstrated at many sites, but complex site conditions at the facility (such as location of the former subtidal area and the marsh crust, groundwater table, tidal influences, and infiltration of seawater), would make excavation operations difficult.

Because of the scale and complex nature of the action, the implementability of Alternative 3 would be low.

Cost

The present worth cost for Alternative 3 would be approximately $1,564,262,458 and is detailed in Appendix A. These costs would include additional characterization of the former subtidal area and marsh crust, excavation and backfilling, waste transport and disposal, and other miscellaneous costs and contingencies.

3.2.1.4 Alternative 4 - Excavation and On-Site Thermal Desorption

Alternative 4, excavation and on-site thermal desorption, consists of excavation of the former subtidal area and the marsh crust, on-site treatment of the former subtidal area and the marsh crust using the thermal desorption process, and backfilling and restoration of excavation areas with treated soil. Excavation, backfilling with clean overburden and fill, and restoration activities for removal and treatment of the former subtidal area and the marsh crust underlying Alameda Facility/Alameda Annex would be similar to the activities described in Section 3.2.1.3. The thermal desorption process has been used successfully as a full-scale soil remediation technology to treat organic contaminants such as VOCs and SVOCs, including PAHs (EPA 1993). It would be operated at a temperature that is sufficient to volatilize PAH contaminants in the former subtidal area and marsh crust, but not to destroy the contaminants. The desorption unit would heat contaminated soil, and water and contaminants would be volatilized. An inert gas, such as nitrogen, or oxygen-deficient (less than 4 percent) combustion off-gas would be injected as a sweep stream. Organic compounds in the off-gas would be collected and burned in an afterburner. Particulate matter would be removed by conventional air pollution control methods. A cleanup goal for treated soil would be established that is protective of future exposure due to construction activities. This cleanup goal was not developed for use in this FS, because the absence of a cleanup goal does not significantly affect the evaluation of this alternative.

Operation of the thermal desorption system would create the following process residual streams: treated soil; untreated, oversized rejects; condensed contaminants and water; particulate control-system dust; clean off-gas; and spent carbon, if used. Treated soil, debris, and oversized rejects could be suitable for return on site. Treated condensed water and treated scrubber purge water (blowdown) could be purified and returned to the Alameda Facility/Alameda Annex wastewater treatment facility (if available), sent for disposal to a sewer system, or used for rehumidification and cooling of the hot, dusty media. Trial-burn test runs would be required before implementing this alternative.

Clean off-gas would usually be released to the atmosphere, although systems that use an inert gas (for example, nitrogen) would recycle the gas to the desorber after treatment. Residual treated soil should remain stockpiled on site until analytical results are received. Treated soil would be tested for PAHs to verify the effectiveness of the treatment processes and demonstrate that the soil no longer exhibits hazardous waste characteristics or poses threat to human health or the environment. The soil will then be used to fill excavated areas. All soil will be stockpiled within the area of contamination prior to treatment.

Overall Protection of Human Health and the Environment

Implementation of Alternative 4 will provide for overall protection of human health and the environment by eliminating the source of contamination. Residual risks would be very small after implementing this alternative. Compliance with ARARs during implementation of this alternative will protect human health and the environment. Alternative 4 meets the RAO by permanently removing the former subtidal area and the marsh crust and by treating contaminated soil and other waste streams on site. The former subtidal area and the marsh crust would be treated by the thermal desorption process. Other waste streams would be treated and eliminated. This alternative has similar short term risks to Alternative 3, excavation and off-site disposal, although risks to the community are further reduced under this alternative because of reduced transport of contaminated materials. Moderate short-term risk to workers and the environment would be created, and these risks are similar to those described under Alternative 3. Alternative 4, therefore, is considered to be protective of human health and the environment.

Compliance with ARARs

No chemical-specific ARARs have been identified for Alternative 4.

Alternative 4 would comply with all location- and action-specific ARARs. As stated in Section 3.2.1.3 (Alternative 3), the Navy will comply with all hazardous waste ARARs identified for excavation and handling of contaminated media, and these same ARARs will be followed for this alternative. These ARARs are described under Alternative 3. In addition, the substantive performance standards for miscellaneous RCRA units in 22 CCR 66264.601 are relevant and appropriate to operation of the thermal desorption unit. If the former subtidal area and marsh crust materials must be managed as hazardous waste, BAAQMD Regulation 2-2-301, which requires use of best available control technologies for new sources, may also be relevant and appropriate to the treatment of the former subtidal area and the marsh crust and possibly contaminated groundwater by thermal desorption because nitrogen oxides, VOCs, SVOCs, or other ozone precursors could be emitted in sufficient quantities for the facility to be considered a new source under BAAQMD rules. These action-specific ARARs are listed in Table 3-1, along with those identified already for Alternative 3.

Alternative 4 would satisfy the criterion of compliance with ARARs.

Long-Term Effectiveness and Permanence

The removal and on-site treatment of the former subtidal area and the marsh crust would eliminate the source of contamination. Under Alternative 4, the former subtidal area and the marsh crust would be removed and treated on site using a thermal desorption process. Excavation and on-site treatment with thermal desorption are established technologies that would meet the RAO after approximately 2 years. If implemented properly and the thermal desorption process would perform well for contaminants in the former subtidal area and marsh crust, no possibility of future exposure to PAHs found in the former subtidal area and marsh crust would exist. A proof of performance test is required for reliability of the thermal desorption process for contaminants in the former subtidal area and marsh crust. Because the former subtidal area and the marsh crust would be removed, Alternative 4 would have high effectiveness over the long term.

Reduction of Toxicity, Mobility, or Volume through Treatment

Excavation and thermal desorption treatment processes would reduce the toxicity, mobility, and volume of the former subtidal area and marsh crust contaminants.

The entire mass or volume of the former subtidal area and the marsh crust would be treated and destroyed by the thermal desorption process under Alternative 4. Results from a variety of Superfund Innovative Technology Evaluation demonstrations and full-scale cleanup studies indicate that thermal desorption systems could effectively remove contaminants to low residual concentrations or to concentrations below detection limits in treated soil. However, trial-burn test runs would be required to confirm the effectiveness of the thermal desorption system.

The mass, mobility, and volume of contaminants would be reduced by nearly 99.99 percent through thermal desorption in combination with off-gas destruction by an afterburner. The effects of the thermal desorption treatment would be irreversible because toxic contaminants would be removed permanently and destroyed in the off-gas treatment system. Treatment residuals would not pose any risks. Alternative 4 would satisfy the statutory preference for treatment as a principal element of the remedy. Alternative 4, therefore, would have high effectiveness at satisfying the criterion of reduction of toxicity, mobility, or volume through treatment.

Short-Term Effectiveness

Short-term risks to workers and the community during soil excavation activities are discussed previously in Section 3.2.1.3 (under Alternative 3). Risks to the community would be lower than under Alternative 3 because of reduced transport of contaminated materials. However, there would be potential risks from fugitive dust. In addition, the community could be exposed to emissions of unburned SVOCs in off-gas from the afterburner. This potential exposure would be minimized by developing standards for off-gas and dust emissions. Compliance with standards would be demonstrated during trial-burn testing and by testing during remedial activities. Fugitive emissions at the feed point of the thermal desorption unit would be controlled by enclosing screens and feed conveyors; fugitive emissions from the discharge point of the thermal desorption system would be controlled by quenching hot, dry solids.

Alternative 4, excavation and on-site thermal desorption would require a highly organized and costly effort to control short-term risks. However, because large volumes of excavated the former subtidal area and the marsh crust would not be transported to an off-site disposal facility under this alternative, it would cause less short-term risk to the community than Alternative 3. This alternative, therefore, would have moderate to high effectiveness in the short-term.

Implementability

Alternative 4 would encounter the same difficulties during excavation as described in Section 3.2.1.3 (Alternative 3). Additional implementability concerns would exist related to the performance and control of the on-site thermal desorption unit to treat such a large volume of soil.

Implementability of Alternative 4 would be low because of the scale of the effort and the complex nature of site conditions.

Cost

The present worth cost for Alternative 4 would be approximately $981,696,393 (see Appendix A). These costs include additional characterization of the former subtidal area and the marsh crust, excavation and backfilling, on-site treatment of the former subtidal area and the marsh crust, and other miscellaneous costs and contingencies.

3.2.2 Groundwater Alternatives

This section describes the two groundwater alternatives developed in Section 2.5 and evaluates each alternative against the seven CERCLA evaluation criteria.

3.2.2.1 Alternative 1 (Groundwater) - No Action

No remedial action would be taken under Alternative 1, no action. Physical conditions at the Alameda Facility/Alameda Annex would remain unchanged. Contaminants found in groundwater would be left in place. No institutional controls, containment, removal, or treatment would be implemented, and no other mitigating actions would be taken. Alternative 1 is retained throughout the FS process, as required by the NCP, to provide a comparative baseline against which other alternatives can be evaluated.

Overall Protection of Human Health and the Environment

Currently, the shallow groundwater does not pose a risk to human health because no complete exposure pathways are present. Further, shallow groundwater does not have beneficial use as drinking water because of high TDS. Although there is currently no complete exposure pathway to the groundwater contamination at Alameda Facility/Alameda Annex, unacceptable risk is possible if accidental ingestion by humans were to occur for an extended period or if ingestion were to result from well construction inconsistent with current well construction regulations. Therefore, Alternative 1 may not protect public health and the environment because no action would be taken to ensure that site occupants do not illegally or accidentally consume shallow groundwater. Therefore, potential risks from contaminated groundwater would remain under Alternative 1.

Compliance with ARARs

No ARARs would apply to Alternative 1.

Long-Term Effectiveness and Permanence

No remedial action would be conducted under Alternative 1 to prevent unauthorized use of shallow groundwater by the site occupants in the future; therefore, this alternative would provide no long-term effectiveness or permanence, and residual risk would remain at the site. For these reasons, Alternative 1 may have low effectiveness over the long term.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 1 would not reduce the toxicity, mobility, or volume of hazardous substances in the shallow groundwater at Alameda Facility/Alameda Annex because no treatment is employed for contaminated groundwater under this alternative. Alternative 1 would, therefore, not satisfy the statutory requirements for treatment as a principal element.

Short-Term Effectiveness

Because the Alternative 1 would involve no construction activities, the alternative would not pose new health risks to the community, current occupants, or workers. This alternative also would not pose short-term risks to the environment. Alternative 1 would, therefore, have high effectiveness in the short term.

Implementability

No construction or resources would be required to implement this alternative, and no known administrative considerations would impact its overall implementability; therefore, implementability of Alternative 1 would be high.

Cost

No known capital or O&M costs would be associated with the no action alternative.

3.2.2.2 Alternative 2 (Groundwater) – Institutional Controls and Groundwater Monitoring

Under Alternative 2, institutional controls and groundwater monitoring would be implemented to ensure that site occupants do not consume shallow groundwater. Specific actions required for the implementation of this alternative would include the following:

- The DTSC would enter into a land use covenant restricting future occupants from drinking or discharging the shallow groundwater. The land use covenant would provide assurances for its future enforcement.
- The City of Alameda and the State of California would continue to enforce the existing State of California and Alameda County Well Construction Standards to restrict construction of water supply wells for drinking.
- The Navy would implement groundwater monitoring for a limited period (up to 5 years) to determine whether contaminants are migrating off site at concentrations that pose a threat to human health or the environment.
- Regular review would be performed every 5 years to ensure long-term compliance with institutional controls.

Overall Protection of Human Health and the Environment

Alternative 2 would protect human health and the environment under current and likely future land uses because institutional controls under this alternative would prevent site occupants from unauthorized use of shallow groundwater. Potential risks from contaminated groundwater would be reduced by the imposition of institutional controls.

Alternative 2 would, therefore, be protective of human health and the environment.

Compliance with ARARs

No chemical- or action- specific ARARs would apply to Alternative 2 for unauthorized shallow groundwater use. This alternative would comply with the identified location-specific ARARs.

Long-Term Effectiveness and Permanence

Under Alternative 2, the institutional controls would supplement the existing government controls to limit exposure from groundwater use over the long term. Human health risks from site groundwater would remain acceptable over the long term, because consumption of groundwater would be restricted through state mandated controls. Existing government controls, such as well construction standards, should be effectively enforced to restrict construction of water supply wells in the shallow groundwater for long-term effectiveness. A land use covenant signed by DTSC would provide the means of restricting groundwater use. The land use covenant would be recorded, and future owners would be notified through title search of the restrictions. The land use covenant would provide added assurance that human health risks at Alameda Facility/Alameda Annex would be adequately managed and unauthorized groundwater use limited in the long term because it gives DTSC enforcement authority (as well as a role in making any changes).

Alternative 2 would, therefore, have high effectiveness over the long term.

Reduction of Toxicity, Mobility, or Volume through Treatment

Because Alternative 2 would not employ any treatment for contaminated groundwater to reduce the toxicity, mobility, or volume of hazardous substances in the groundwater, Alternative 2 is not effective for this criterion.

Short-Term Effectiveness

Alternative 2 would involve no remedial action construction activities, so this alternative would not pose new health risks to the community, current occupants, or workers. Alternative 2 meets the RAO for groundwater; therefore, this alternative would have high effectiveness in the short term.

Implementability

Alternative 2 would be technically and administratively implementable. Land use covenants would require negotiation with several parties. However, institutional controls described under this alternative could be prepared and filed without significant delays; therefore, the implementability of Alternative 2 would be high.

Cost

No known capital or O&M costs would be associated with alternative 2. The immediate costs for implementing this alternative are estimated at $396,859. These costs would be for miscellaneous fees and other costs associated with developing and filing the institutional controls. The cost of enforcement and monitoring institutional controls would be, however, uncertain and could be significant. It is assumed for cost estimating purpose that a review would be conducted every 5 years for a period of 30 years to ensure long-term compliance with this alternative. Also, it is assumed for cost-estimating purposes that groundwater monitoring would be conducted annually for a period of 5 years to ensure that contaminants are not migrating off site at concentrations that pose a threat to human health or the environment.

3.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents a comparative analysis of remedial alternatives analyzed individually for both the former subtidal area and the marsh crust and groundwater in the previous sections. The comparative analysis of remedial alternatives evaluates the relative performance of each alternative with respect to seven of the nine specific NCP evaluation criteria presented in Section 3.1. The first two applicability criteria (overall protection of human health and the environment and compliance with ARARs) serve as threshold criteria in that they must be met by an alternative in order to be eligible for selection. The next five applicability criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost) serve as balancing criteria that are compared so that major tradeoffs among the alternatives are identified and weighed in the decision-making process. The last two criteria, state acceptance and community acceptance, will be addressed in the ROD following comment by the state on the FS report and proposed plan and comment by the public on the proposed plan. Table 3-2 summarizes the effectiveness of the four alternatives for the marsh and former subtidal area and two alternatives for the shallow groundwater as compared to the seven criteria.

The purpose of this comparative analysis is to identify the relative advantages and disadvantages of each alternative and thereby provide a sound basis for remedy selection that is consistent with the NCP. The NCP states, "The national goal of the remedy selection process is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste."

This comparative analysis presented in the following sections provides the information needed to decide which alternative or set of alternatives best satisfies the goals and expectations of the NCP.

3.3.1 Overall Protection of Human Health and the Environment

This section evaluates the overall protection of human health and the environment provided by each alternative for the former subtidal area, marsh crust, and groundwater.

Former Subtidal Area and Marsh Crust Alternatives

All alternatives, even Alternative 1, would protect human health and the environment under current and likely future land uses. Future construction at Alameda Facility/Alameda Annex and Alameda Point could result in contamination from the marsh crust and former subtidal area being brought to the surface. In such an event, Alternative 1 may not be protective. Alternative 2 would provide a reliable method of ensuring that landowners do not excavate the marsh crust and former subtidal area without proper procedures. Although Alternatives 3 and 4 would be best at eliminating potential contamination in the former subtidal area and the marsh crust in the long term, the magnitude of effort to implement these alternatives is excessive. With regard to short-term risks, Alternatives 1 and 2 are more effective in protecting the community, current occupants, site workers, and the environment than Alternatives 3 and 4 because no construction activities would be undertaken under Alternatives 1 and 2. Massive disruption to the environment and the community would be caused by construction activities involved in implementing Alternatives 3 and 4.

Groundwater Alternatives

Under current land uses, shallow groundwater does not pose a risk to human health and the environment. Alternative 2 would be more protective to human health and the environment because institutional controls under this alternative would ensure that site occupants do not consume shallow groundwater or install wells in violation of current well construction standards. Alternative 1 does not provide the same level of assurance that site occupants would not consume shallow groundwater in the future. Potential risks from consumption of contaminated shallow groundwater remain under Alternative 1.

3.3.2 Compliance with Applicable or Relevant and Appropriate Requirements

No chemical- or action-specific ARARs apply to Alternatives 1 and 2 for the former subtidal area and the marsh crust and shallow groundwater. Alternative 2 for shallow groundwater would comply with location-specific ARARs. Both Alternatives 3 and 4 for the former subtidal area and the marsh crust would comply with all ARARs.

3.3.3 Long-Term Effectiveness and Permanence

This section evaluates the long-term effectiveness and permanence provided by each alternative for the former subtidal area, marsh crust, and groundwater.

Former Subtidal Area and Marsh Crust Alternatives

Alternatives 3 and 4 would provide the highest level of long-term effectiveness and permanence because the former subtidal area and marsh crust would be excavated, thereby leaving no significant residual risks and removing the potential for exposure to hazardous substances in soil. The potential for residual risks from contaminants in the former subtidal area and marsh crust would remain under Alternative 2; however, protection of human health would be achieved by restricting excavation in the former subtidal area and marsh crust unless health and safety and disposal procedures were taken to minimize exposure. No remedial action would be conducted under Alternative 1; therefore, Alternative 1 would provide no long-term effectiveness or permanence, and residual risk would remain at the site in the unlikely event that the former subtidal area and marsh crust are brought to the surface. Both Alternatives 3 and 4 would be adequate and reliable in concept because they would result in massive removal of former subtidal area and the marsh crust.

Groundwater Alternatives

Alternative 2 would provide the highest level of long-term effectiveness and permanence because the potential for exposure to contaminated groundwater would be reduced by the imposition of government and proprietary controls. No remedial action would be conducted under Alternative 1; therefore, Alternative 1 would provide no long-term effectiveness or permanence, and residual risk would remain at the site in the unlikely event occupants constructed wells in violation of current well construction standards.

3.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This section evaluates the reduction of toxicity, mobility, or volume through the treatment of contaminants under each alternative for the former subtidal area, marsh crust, and groundwater.

Former Subtidal Area and Marsh Crust Alternatives

Alternative 4 would provide the greatest reduction in the toxicity, mobility, and volume through treatment of contaminants in the former subtidal area and marsh crust. None of the other alternatives would use treatment to reduce toxicity, mobility, or volume.

Groundwater Alternatives

Neither Alternative 1 nor 2 would be effective for this criterion because they would not employ any treatment for contaminated shallow groundwater to reduce the toxicity, mobility, or volume of hazardous substances in the groundwater. The contaminants would remain in the groundwater under both Alternatives 1 and 2; therefore, neither Alternative 1 nor 2 would not satisfy the statutory requirements for treatment as a principal element.

3.3.5 Short-Term Effectiveness

This section evaluates the short-term effectiveness of each alternative for the former subtidal area, marsh crust, and groundwater.

Former Subtidal Area and Marsh Crust Alternatives

Both Alternatives 1 and 2 would provide the highest level of short-term protection to the community, workers, and the environment because no site construction would be required under these alternatives. Both Alternatives 3 and 4 are considered to have less effectiveness in the short term because of the massive excavation of the former subtidal area and marsh crust and the handling of large quantities of contaminated soil and groundwater (during dewatering activities). In addition, Alternative 3 could cause an additional short-term risk to the community because of the large number of truck trips that would occur while transporting soil from the former subtidal area and the marsh crust off site for disposal.

Implementation of Alternatives 1 and 2 would have no impact on the environment because no construction activities would be involved. Both Alternatives 3 and 4 would have significant, short-term adverse impacts to the environment because of the complex nature of excavation of a large volume and area below the groundwater table and the treatment and handling of a large volume of contaminated soil or residual treatment materials.

Alternative 2 would require a minimal amount of time to implement; whereas Alternatives 3 and 4 would take several years to implement.

Groundwater Alternatives

Neither Alternative 1 nor Alternative 2 for groundwater presents short-term potential health risks or physical hazards to the community, workers, or the environment because neither alternative would include construction activities at the facility.

3.3.6 Implementability

This section evaluates the implementability of each alternative for the former subtidal area, marsh crust, and groundwater.

Former Subtidal Area and Marsh Crust Alternatives

Alternative 1 would be easy to implement because no action would be taken. Alternative 2 could be implemented without significant delays because no construction activities are involved. Both Alternatives 3 and 4 would be difficult to implement because of the complex nature of site conditions described previously, excavation of a large volume and area below the groundwater table, and the handling requirements of a large volume of contaminated soil and treatment residuals.

Groundwater Alternatives

Alternative 1 would be easy to implement because no action would be taken under this alternative. Alternative 2 would be more difficult to implement because of the coordination required between the Navy and DTSC to develop the land use covenant.

3.3.7 Cost

This section evaluates the cost of each alternative for the former subtidal area, marsh crust, and groundwater.

Former Subtidal Area and Marsh Crust Alternatives

No known costs would be associated with Alternative 1. Alternative 2 would cost about $97,440 to implement institutional controls for both facilities. The estimated cost of implementing Alternatives 3 and 4 would be $1.564 billion and $0.982 billion, respectively. Though these cost figures are only estimates, with an estimated margin for error of between minus 30 and plus 50 percent, these costs would be vastly greater than the costs for Alternatives 1 and 2. The costs of implementing Alternatives 3 and 4 are excessive when compared to Alternatives 1 and 2.

Shallow Groundwater Alternatives

No known costs would be associated with Alternative 1. Alternative 2 would cost about $396,859 to implement institutional controls and groundwater monitoring.

3.3.8 Comparative Analysis of Alternatives Summary

For the former subtidal area and the marsh crust, the comparative analysis indicates that Alternative 2, consisting of a land use covenant, provides overall protection of human health and the environment, meets the threshold criteria for remedy selection, and is cost-effective. Alternative 1 may not be protective of public health and the environment. While protective of human health and the environment, Alternatives 3 and 4 potentially have less effectiveness in the short and long term because of the disruption expected from such a massive excavation and either off-site disposal or on-site treatment. In addition, the costs for implementing Alternatives 3 and 4 are excessive when compared to Alternatives 1 and 2. According to the

NCP (40 CFR Subsection 430(e)(7)(iii)), "costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of the several factors used to eliminate alternatives." Although this NCP provision is specifically directed to the screening of remedial alternatives, it is also relevant to the detailed analysis of alternatives under an FS. Consideration of Alternatives 3 and 4 shows that they would provide no greater effectiveness or improved implementability than Alternative 2 and at a grossly excessive cost.

For shallow groundwater at Alameda Facility/Alameda Annex, the comparative analysis indicates that Alternative 2 is protective of human health and would meet all of the evaluation criteria. Although risks are currently acceptable given site conditions and existing controls, Alternative 1 would not provide sufficient protection to public health in the event that site occupants ignored current well construction standards and installed wells.

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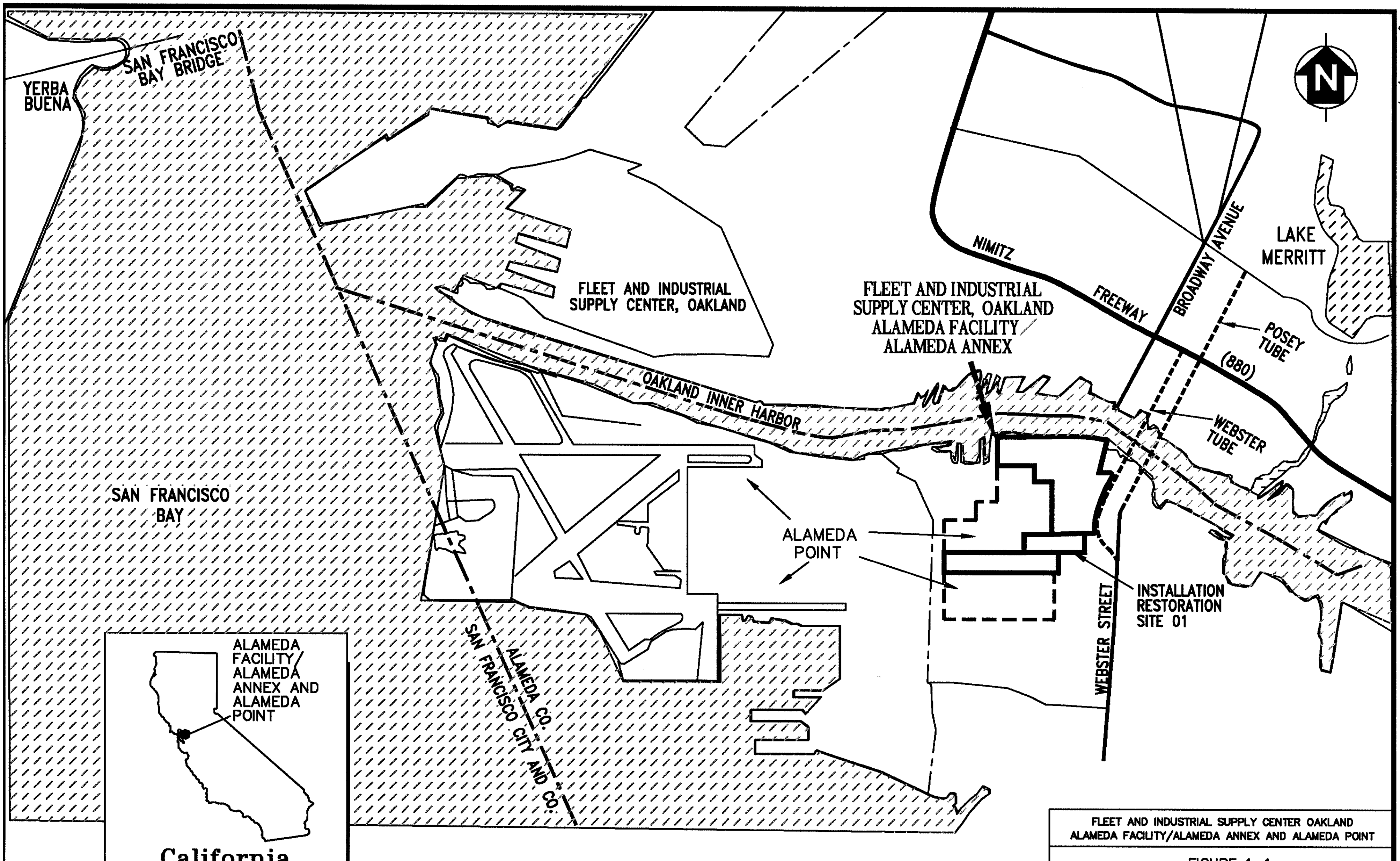

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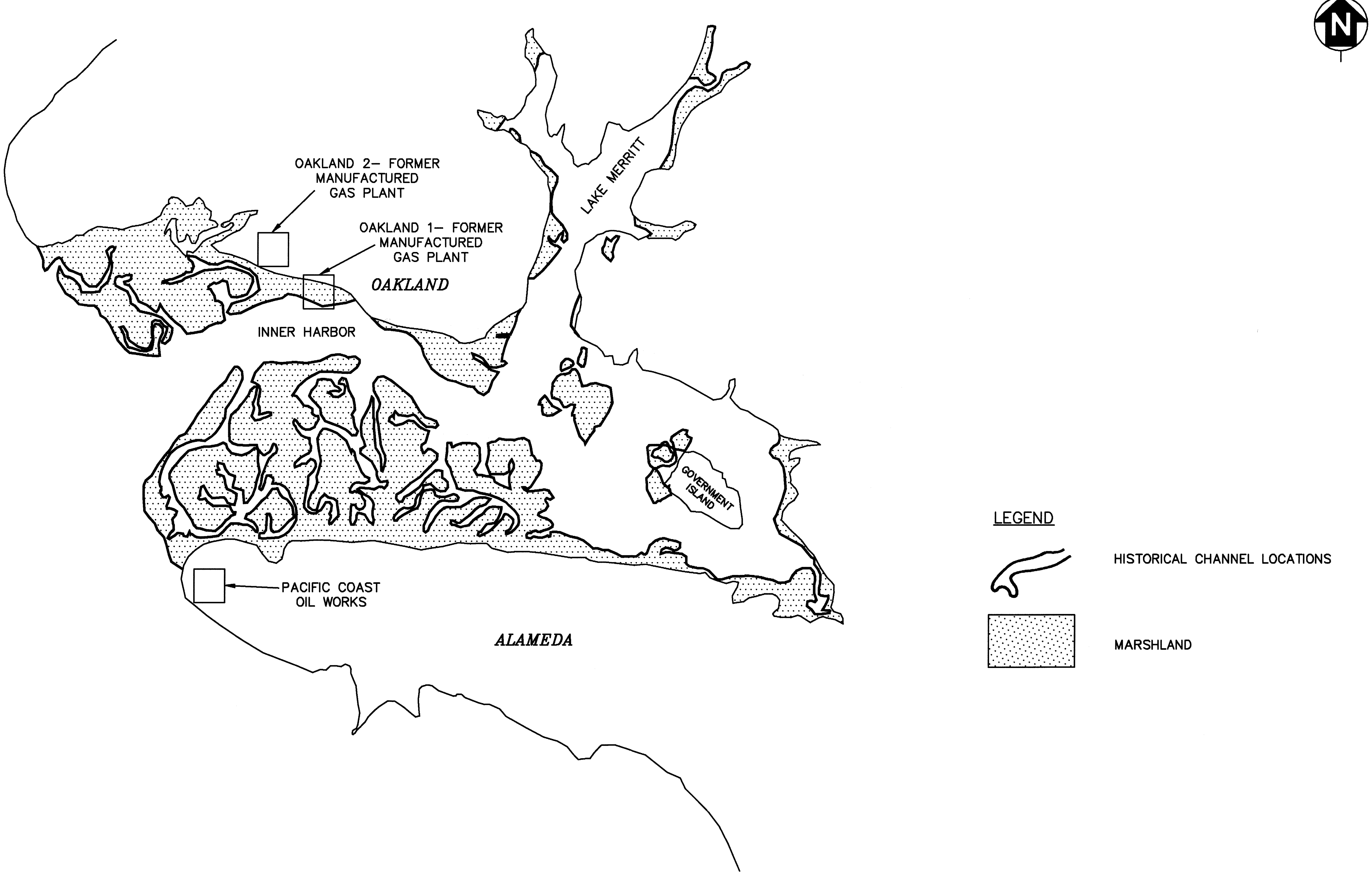
SOURCE: USGS OAKLAND WEST, CALIFORNIA QUADRANGLE 1980

FLEET AND INDUSTRIAL SUPPLY CENTER OAKLAND
ALAMEDA FACILITY/ALAMEDA ANNEX AND ALAMEDA POINT

FIGURE 1-1

SITE LOCATION MAP

TETRA TECH EM INC.



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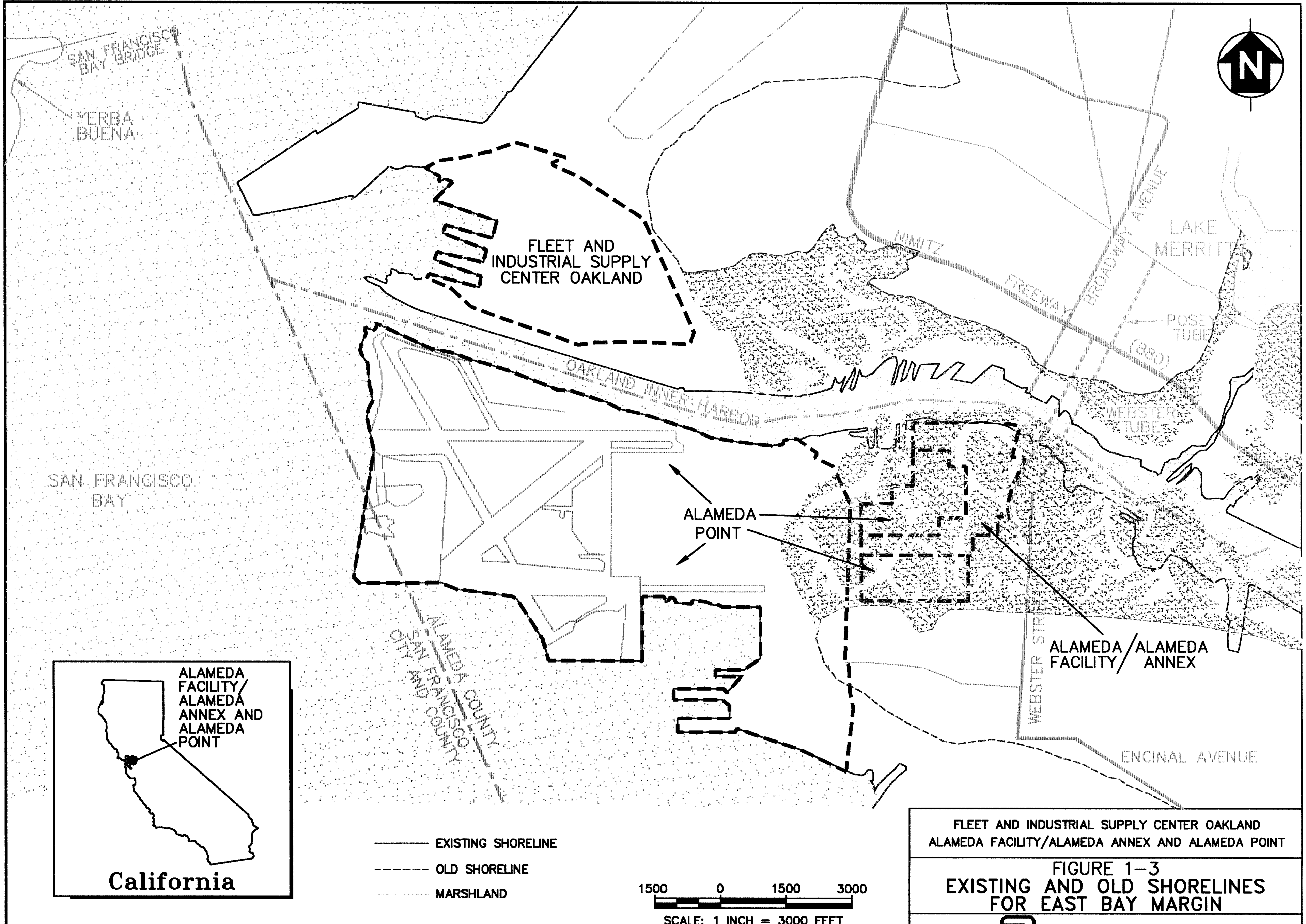
SCALE: 1 INCH = 1/2 MILE

FLEET AND INDUSTRIAL SUPPLY CENTER OAKLAND
ALAMEDA FACILITY/ALAMEDA ANNEX AND ALAMEDA POINT

FIGURE 1–2
FORMER OAKLAND INNER HARBOR MAP

TETRA TECH EM INC.

SOURCE: PRC Environmental Management, Inc. 1996 figure 1-3 - 12/27/99 - JPW



SOURCE: USGS, OAKLAND WEST, CALIFORNIA QUADRANGLE 1980

FLEET AND INDUSTRIAL SUPPLY CENTER OAKLAND
ALAMEDA FACILITY/ALAMEDA ANNEX AND ALAMEDA POINT

FIGURE 1-3
EXISTING AND OLD SHORELINES FOR EAST BAY MARGIN

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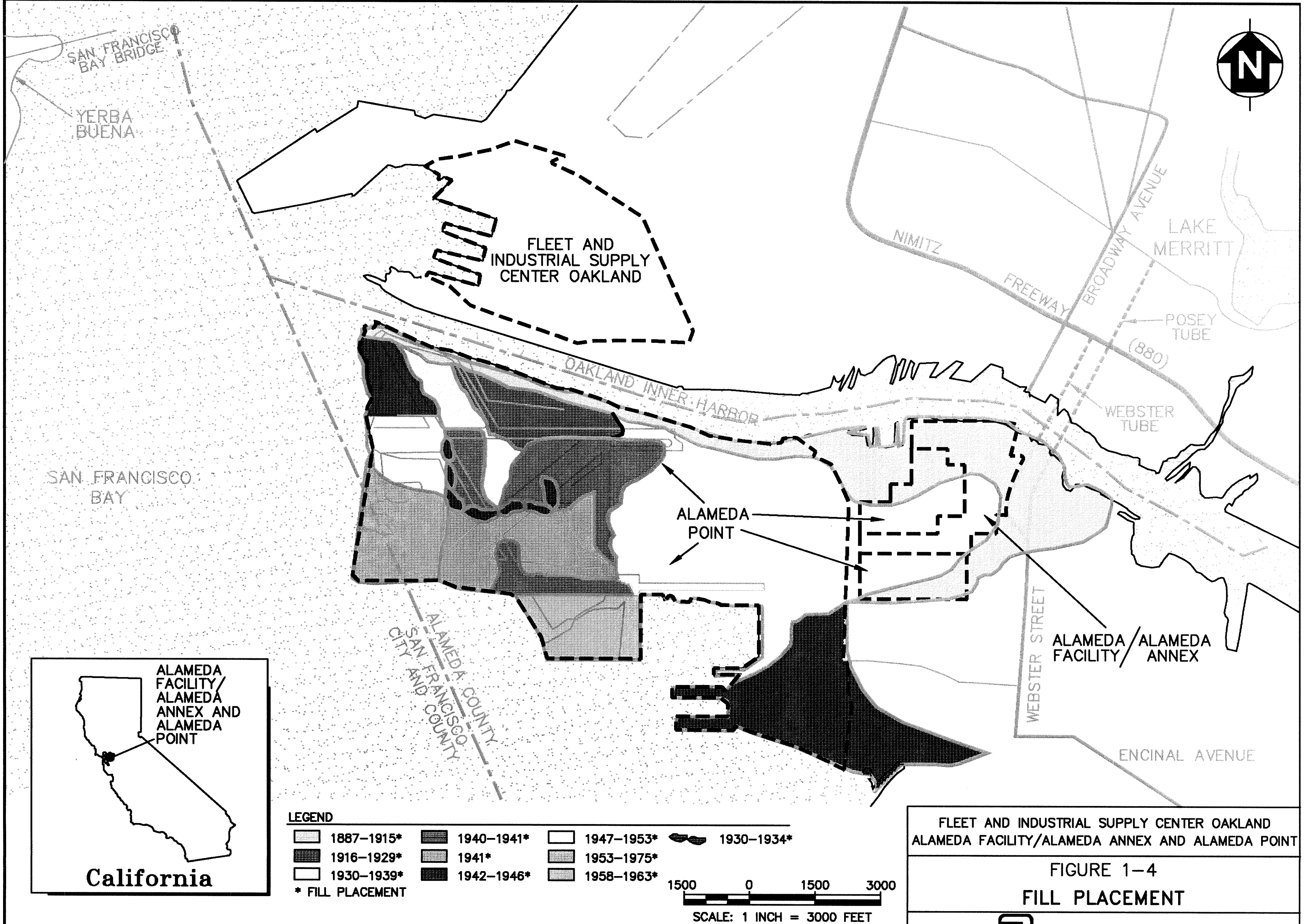
figure 1-4.DWG - 12/27/99- JPW



SOURCE: USGS, OAKLAND WEST, CALIFORNIA QUADRANGLE 1980

FLEET AND INDUSTRIAL SUPPLY CENTER OAKLAND
ALAMEDA FACILITY/ALAMEDA ANNEX AND ALAMEDA POINT

FIGURE 1–4

FILL PLACEMENT

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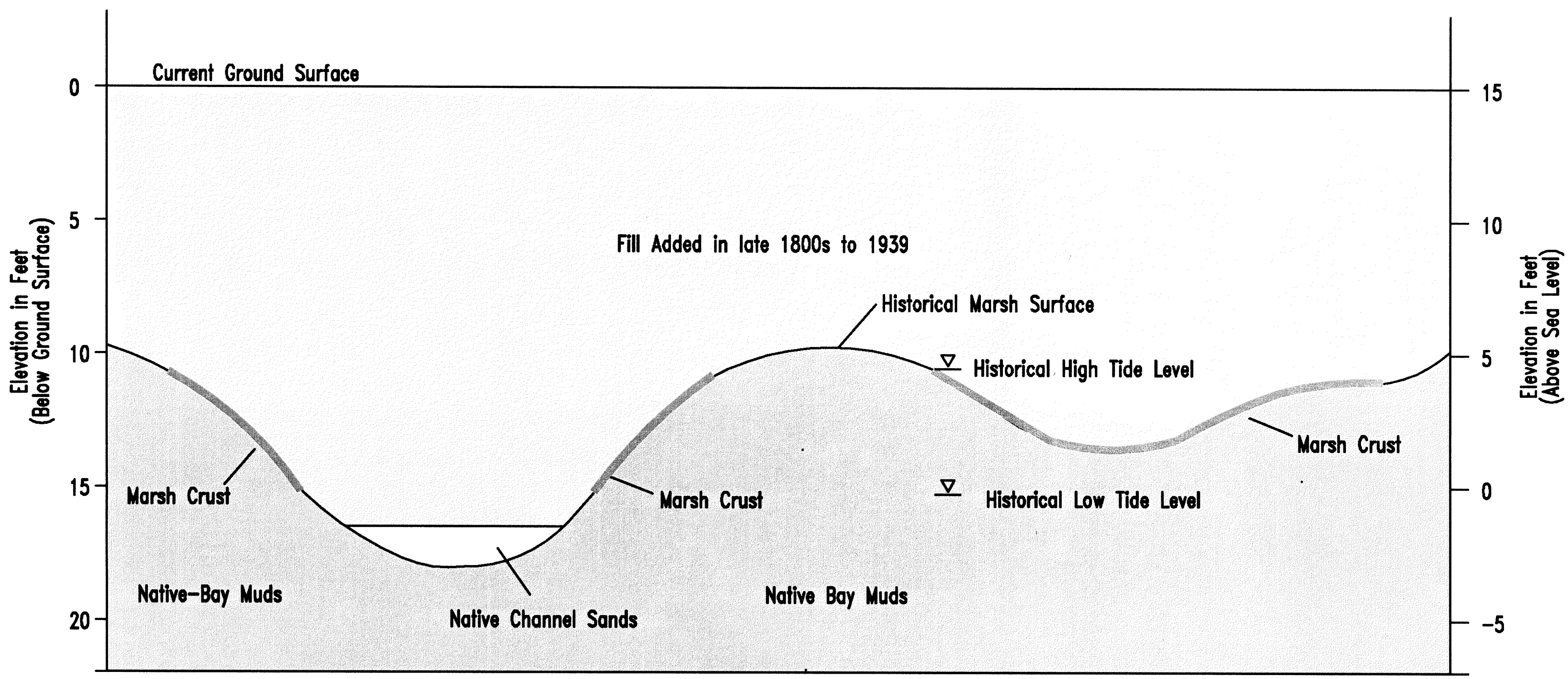
FIGURE 1-5.DWG – 12/27/99 – JPW



NOTE: MAP IS BASED ON BORING LOGS AND HISTORICAL RECORDS.

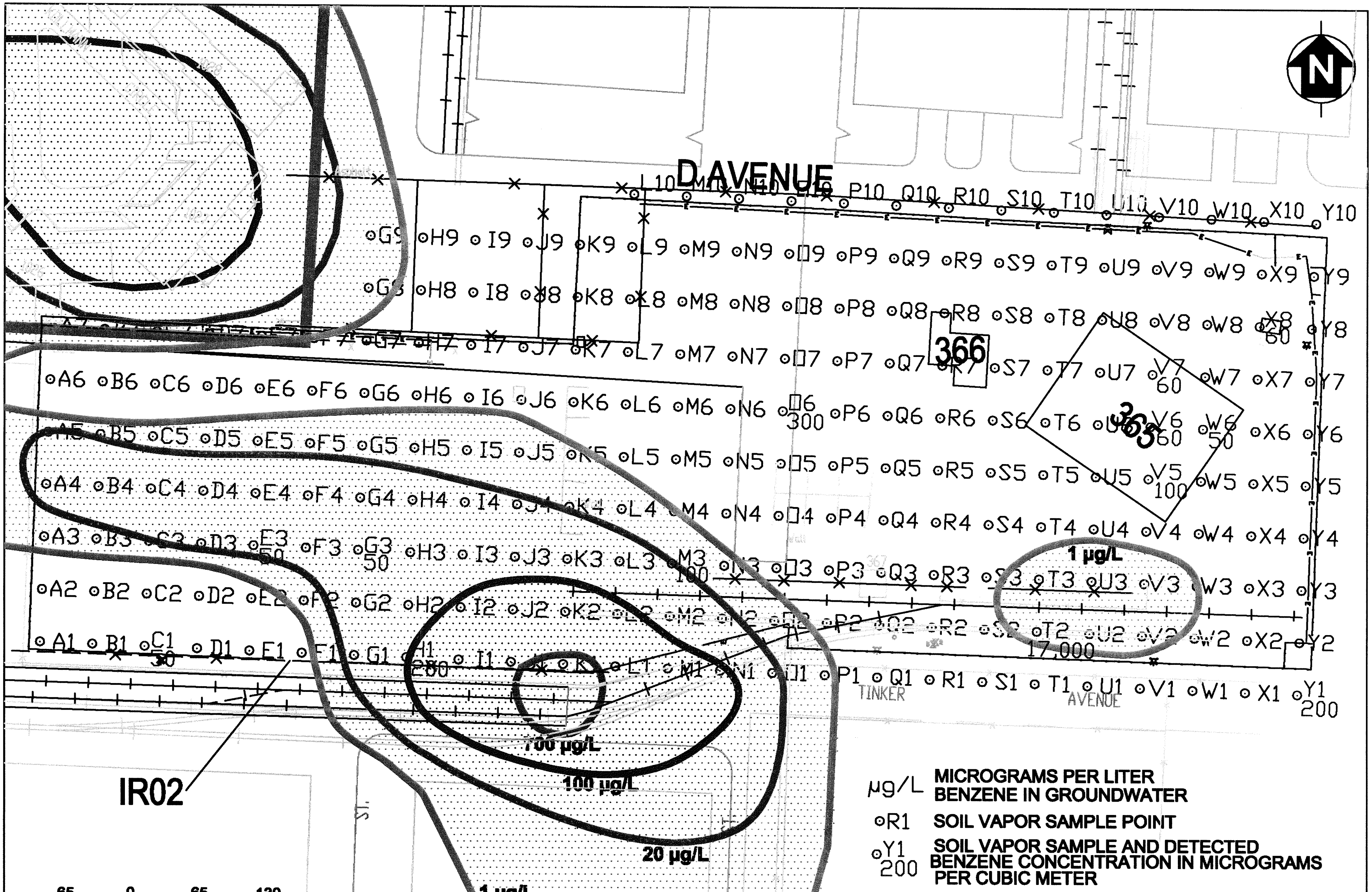
FLEET AND INDUSTRIAL SUPPLY CENTER OAKLAND
ALAMEDA FACILITY/ALAMEDA ANNEX AND ALAMEDA POINT

FIGURE 1–5

GENERALIZED GEOLOGIC CROSS-SECTION OF TIDAL CHANNELS

TETRA TECH EM INC.

Figures 1-6 thru 1-11 are in D size (24"x36").
Without the source file, PDF conversion is not attempted.



FLEET AND INDUSTRIAL SUPPLY CENTER OAKLAND
ALAMEDA FACILITY/ALAMAEDA ANNEX AND ALAMEDA POINT

FIGURE 1-12
SOIL VAPOR SAMPLE LOCATIONS AND BENZENE IN SOIL VAPOR AND GROUNDWATER AT IR02

TETRA TECH EM INC.

NEWBENZENE.DWG ASC 12/09/99 G0069-236B0401

TABLE 2-1

POTENTIAL LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
ALAMEDA FACILITY/ALAMEDA ANNEX AND ALAMEDA POINT
(Page 1 of 1)

Citation	ARAR Classification	Description	Comments
Federal Location-Specific ARARs			
Coastal Zone Management Act 16 USC 1456(c)(1)(A); Title 15 CFR Part 930	Relevant and appropriate	The Act requires federal agencies to conduct activities affecting the coastal zone consistent to the maximum extent practicable with approved state management programs.	Alameda Facility/Alameda Annex and Alameda Point are not located within the coastal zone; however, active remedial activities at the facility may affect land or water use or natural resources of the coastal zone at adjacent facilities.
State Location-Specific ARARs			
McAteer-Petris Act (California Government Code Section 66600 and following sections)	Relevant and appropriate	The state management program for San Francisco Bay is contained in the Bay Conservation and Development Commission Bay Plan, enacted pursuant to the McAteer-Petris Act of 1965. It establishes requirements for prescribed activities affecting San Francisco Bay.	Alameda Facility/Alameda Annex and Alameda Point are not located within the coastal zone, however, active remedial activities at the facility may affect land or water use, or natural resources of the coastal zone at adjacent facilities.
California Water Pollution Prohibition Act (California Fish and Game Code Section 5650)	Relevant and appropriate	The Act prohibits the deposition, directly or indirectly, into waters of the state of any substance or material that is deleterious to fish, plant, or bird life.	The Act is relevant to protect fish, plants or birds that may use the Oakland Inner Harbor from contamination resulting from excavation and treatment activities.

Notes:

ARAR	Applicable or relevant and appropriate requirements
CFR	Code of Federal Regulations
USC	U.S. Code

TABLE 3-1
POTENTIAL ACTION- SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR THE FORMER SUBTIDAL AREA AND MARSH CRUST ALAMEDA FACILITY/ALAMEDA ANNEX AND ALAMEDA POINT
(Page 1 of 3)

Citation	ARAR Classification	Description	Comments
Alternative 1 – No Action			
Federal Action-Specific ARARs – None			
State Action-Specific ARARs – None			
Alternative 2 – Institutional Controls			
Federal Action-Specific ARARs – None			
State Action-Specific ARARs – None			
Alternative 3 – Excavation and Off-Site Disposal			
Federal Action-Specific ARARs [1]			
22 CCR Sections 66261.10 and 66261.24(a)(1)	Applicable	Establishes criteria for identifying hazardous waste	These requirements will apply to characterize excavated soil to determine whether it must be managed as hazardous waste.
22 CCR Sections 66262.1, 66262.11, 66262.20, 66262.30, 66262.31, 66262.32, 66262.33, and 66262.34	Applicable	Establishes standards for generators of hazardous waste	If excavated soil is hazardous waste, these requirements will apply to managing excavated soil prior to shipment off site.
22 CCR Section 66268.7(a)	Applicable	Sets requirements for testing excavated soil to see if it is restricted for land disposal	This regulation requires generators to determine if treatment is required prior to land disposal. The Navy will ensure that necessary analyses are conducted.
State Action-Specific ARARs			
22 CCR Section 66261.24(a)(2)	Applicable	Establishes criteria for identifying California hazardous waste	This requirement applies to characterize excavated soil to determine if it is California hazardous waste.
BAAQMD Regulations 6-301, 302, and 305	Relevant and appropriate	Sets requirements for controlling particulate and visible emissions during excavation and transport	These requirements may be applicable to excavation and handling of soils.

TABLE 3-1 (Continued)

POTENTIAL ACTION- SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR THE FORMER SUBTIDAL AREA AND MARSH CRUST ALAMEDA FACILITY/ALAMEDA ANNEX AND ALAMEDA POINT

(Page 2 of 3)

Citation	ARAR Classification	Description	Comments
BAAQMD Regulations 8-40-301 and 8-40-303	Applicable	Limits uncontrolled aeration of stockpiled soil	These requirements are applicable to contaminated soil, which is excavated and stockpiled.
23 CCR Section 2546	Relevant and appropriate	Requires precipitation and drainage controls to limit to the greatest extent possible, inundation, erosion, or other conditions affecting stockpiled soil	This requirement is relevant and appropriate to stockpiles generated from excavation of soil if the soil must be managed as a hazardous waste.
Alternative 4 – Excavation and On-Site Thermal Desorption			
Federal Action-Specific ARARs [1]			
22 CCR Sections 66261.10 and 66261.24(a)(1)	Applicable	Establishes criteria for identifying hazardous waste	These requirements will apply to characterize excavated soil and treatment residuals to determine whether materials must be managed as hazardous waste.
22 CCR Section 66268.7(a)	Applicable	Sets requirements for testing excavated soil to see if it is restricted for land disposal	This regulation requires generators to determine if treatment is required prior to land disposal. The Navy will ensure that necessary analyses are conducted.
22 CCR Section 66264.601	Relevant and appropriate	Sets requirements for treatment of hazardous waste in miscellaneous units	This requirement is relevant and appropriate to operation of the thermal desorption process for treatment of the former subtidal area and the marsh crust if the soil must be managed as a hazardous waste.

TABLE 3-1 (Continued)

POTENTIAL ACTION- SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR THE FORMER SUBTIDAL AREA AND MARSH CRUST ALAMEDA FACILITY/ALAMEDA ANNEX AND ALAMEDA POINT
(Page 3 of 3)

Citation	ARAR Classification	Description	Comments
State Action-Specific ARARs			
22 CCR Section 66261.24(a)(2)	Applicable	Establishes criteria for identifying California hazardous waste	This requirement applies to characterize excavated soil to determine whether it is California hazardous waste.
BAAQMD Regulation 6-301, 302, and 305	Relevant and appropriate	Sets requirements for controlling particulate and visible emissions during excavation and transport	These requirements may be applicable to excavation and handling of soil.
BAAQMD Regulation 8-47	Relevant and appropriate	Establishes emission standards for active treatment systems that treat organic compounds in soil	This requirement may be relevant and appropriate to operation of the thermal desorption unit.
BAAQMD Regulation 8-40-301 and 8-40-303	Applicable	Limits uncontrolled aeration of stockpiled soil	These requirements are applicable to contaminated soil that is excavated and stockpiled.
23 CCR Section 2546	Relevant and appropriate	Requires precipitation and drainage controls to limit to the greatest extent possible, inundation, erosion, or other conditions affecting stockpiled soil	This requirement is relevant and appropriate to stockpiles generated from excavation of soil if the soil must be managed as a hazardous waste.
Use of BACT for new sources (BAAQMD Regulation 2-2-301)	Relevant and appropriate	Sets substantive requirements for use of BACT if treatment technology is a new source of precursor organic compounds or nitrogen oxides	Relevant and appropriate if the thermal desorption process emits VOCs, SVOCs, or nitrogen oxides and qualifies as a new source.

Notes:

ARAR	Applicable or relevant and appropriate requirements
BAAQMD	Bay Area Air Quality Management District
BACT	Best available control technologies
CCR	California Code of Regulations
SVOC	Semivolatile organic compounds
VOC	Volatile organic compounds

1 State regulations that are part of a federally authorized or delegated state program are generally considered to be federal ARARs (55 FR 8742).

TABLE 3-2

COMPARATIVE ANALYSIS OF ALTERNATIVES FOR THE FORMER SUBTIDAL AREA AND MARSH CRUST AND GROUNDWATER ALAMEDA FACILITY/ALAMEDA ANNEX AND ALAMEDA POINT

(Page 1 of 1)

Evaluation Criteria	**Former Subtidal Area And Marsh Crust Alternatives**				**Groundwater Alternatives**	
	1 **No Action**	**2** **Institutional Controls**	**3** **Excavation and Off-Site Disposal**	**4** **Excavation and On-Site Thermal Desorption**	**1** **No Action**	**2** **Institutional Controls and Groundwater Monitoring**
Overall Protection of Human Health and the Environment	Not Protective	Protective	Protective	Protective	Not Protective	Protective
Compliance with ARARs	None	None	Complies	Complies	None	None
Long-Term Effectiveness and Permanence	Low	Moderate to high protectiveness	High effectiveness	High effectiveness	Low	High effectiveness
Reduction of Toxicity, Mobility, or Volume through Treatment	Low	Low	Low	High effectiveness	Low	Low
Short-Term Effectiveness	High effectiveness	High effectiveness	Low to moderate effectiveness	Low to moderate protectiveness	High effectiveness	High effectiveness
Implementability	High	High	Low	Low	High	High
Cost (Present Worth)	**$0**	**$97,440**	**$1,564,262,458**	**$981,696,393**	**$0**	**$396,859**

Note:

ARAR Applicable or relevant and appropriate requirement

APPENDIX A

ALAMEDA FACILITY/ALAMEDA ANNEX AND ALAMEDA POINT

COST ESTIMATES

COST ESTIMATES FOR THE ALAMEDA FACILITY/ALAMEDA ANNEX AND ALAMEDA POINT
BASE-WIDE FOCUSED FEASIBILITY STUDY

INTRODUCTION

This cost estimate has two components: (1) cost estimate summaries and (2) facts and assumptions. These estimates and facts and assumptions are initially for Alameda Facility/Alameda Annex only. Next, the costs are extrapolated for the combined site area of Alameda Facility/Alameda Annex and Alameda Point, taking into account facts and assumptions for Alameda Point.

ALAMEDA FACILITY/ALAMEDA ANNEX COST ESTIMATES, FACTS AND ASSUMPTIONS

The cost estimates provide details of cost information (Tables A-1 through A-9). Tables A-1 through A-4 summarize cost items and quantities used to estimate the cost for marsh crust Alternatives 2 through 4 and groundwater Alternative 2, respectively. Alternative 1 (no action) for groundwater and marsh crust does not require a cost estimate. Tables A-5 through A-8 detail the items and quantities used to calculate the costs for sampling (conducting a basewide shallow groundwater monitoring at Alameda facility/Alameda Annex, a base-wide sampling effort to define the full extent of the marsh crust); demolition (demolishing all structures at the facility prior to remedial actions); and excavation, hauling, stockpiling, and backfilling (the operations required to physically remove the overburden material and the marsh crust). Table A-9 provides a list of the correction factors used to adjust costs from the sources consulted.

The second component provides the basic facts and assumptions that are common to all the marsh crust removal alternatives (Alternatives 3 and 4) cost estimates; they are in Tables A-10 through A-12. Table A-10 provides the estimate of overburden soil and contaminated soil volumes. Table A-11 lists the assumptions regarding the types of buildings that exist at the facility and their total square footage. These assumptions are to estimate demolition costs. Table A-12 is a list of unit conversion factors used in the estimates.

COSTS FOR REMEDIAL ALTERNATIVES FOR THE COMBINED AREA OF ALAMEDA FACILITY/ALAMEDA ANNEX AND ALAMEDA POINT

Remediation costs were determined for the combined site area based on the following alternatives:

- Alternative 2: Institutional Controls
- Alternative 3: Excavation and Off-site Disposal
- Alternative 4: Excavation and On-site Thermal Desorption.

Alternative 1, no action, remains at zero cost.

ALTERNATIVE 2

The estimated cost of Alternatives2 is assumed not be dependent on the area of the site. Institutional controls involve administrative and legal procedures that can be done for the same cost whether the site is 143 acres (Alameda Facility/Alameda Annex) or 584 acres (Alameda Point). It is further assumed that the institutional controls will be initiated independently at each site at different times. The costs, therefore, for Alternative 2 for the combined Alameda Facility/Alameda Annex and Alameda Point area is two times the cost for Alameda Facility/Alameda Annex.

ALTERNATIVES 3 AND 4

The common tasks in Alternatives 3 and 4 that were developed for Alameda Facility/Alameda Annex are:

- Task 1.1 Sampling of marsh Crust (to delineate the area requiring remediation)
- Task 1.2 Demolition and disposal
- Task 1.3 Excavation and Haul

The first two tasks are assumed to be directly dependent on the area of the site. The combined area of the two sites (727 acres) is approximately 5.1 times the size of the area of Alameda Facility/Alameda Annex (143 acres). The costs for Tasks 1.1 through 1.3 for Alameda Facility/Alameda Annex were multiplied by 5.1 to get the new costs for these tasks for combined site acreage in both alternatives.

The excavation costs for the combined site acreage is more complex to determine since the depth of overburden on top of the former subtidal area and marsh crust layer was different at the two sites. The following table presents the assumptions were used in the calculations:

FORMER SUBTIDAL AREA AND MARSH CRUST AND GROUNDWATER DEPTH PARAMETERS

Parameter	Alameda Facility/Alameda Annex	Alameda Point
Depth (ft) bgs to top of the former subtidal area and marsh crust	8	15
Thickness (ft) of the former subtidal area and marsh crust layer	1.5	1.5
Average depth to groundwater(ft bgs)	6	6

bgs below ground surface

Line items from the Alameda Facility/Alameda Annex cost estimate that were directly dependent on area were multiplied by 5.1. For those line items where the thickness of a layer is not the same for both sites, the following steps were used to determine the cost for the combined area.

First the cost per acre-ft of volume was calculated for Alameda Facility/Alameda Annex. Next the total volume (acre-ft) is calculated for both sites based on the depth of the layer for each site as described in the table above. The total acre-ft for both sites is then multiplied by the cost per acre-ft for Alameda Facility/Alameda Annex to get the new total cost for each of these line items. The new costs for all the line items were then added to get the total excavation and haul costs for use in Alternatives 3 and 4 for the combined site area (Table A-13).

For the line items of "Dewatering Excavation and Water Treatment" the following methodology was used. For pumping costs, a quantity of 98 million gallons (MG) was determined for Alameda Facility/Alameda Annex (Table A-8). This was calculated by first multiplying 143 acres by the depth of water in the excavation when completed to 16.5 feet bgs (10.5 feet given that the top of groundwater table is assumed to be 6 ft bgs). This value was multiplied by 0.2, the assumed porosity of the soil (fraction of excavated soil volume that holds water) and a conversion factor. It is assumed that the sheet piling around the site is water tight and that no additional water enters the excavation. The quantity of 98 million gallons was multiplied by the cost of $20,000 per million gallons to get the extended cost value.

This extended cost value was converted to a cost per acre-feet of water in Table A-13. This value was multiplied by the total volume of water from both sites. This volume was the 143 acres at Alameda Facility/Alameda Annex times its depth of water in the excavation of 10.5 feet plus the 584 acres of

Alameda Point times its depth of water in the excavation of 2.5 feet (8.5 feet to bottom of excavation minus 6 feet depth to groundwater). The result is in the last column of Table A-13 for Task 1.4.1. For Task 1.4.2, package treatment plant, one treatment plant was assumed to handle all the water from both facilitates.

For Alternative 3, Tasks 1.4 through 1.6 (haul to landfill, landfill dump fee, and import and backfill volume of contaminated soil) were assumed to be directly dependent on the area of the site. This assumption holds since the thickness of the marsh crust is assumed to be 1.5 feet at both sites. The costs for these tasks from Alameda Facility/Alameda Annex were multiplied by 5.1 to get the cost for this task for the combined site area.

For alternative 4, Task 1.4 (on-site thermal desorption) was assumed to be directly dependent on the area of the site. This assumption holds since the thickness of the marsh crust is the assumed to be 1.5 feet at both sites. The costs for this task from Alameda Facility/Alameda Annex was multiplied by 5.1 to get the cost for this task for the combined site area.

INDIRECT CAPITAL COSTS FOR ALL ALTERNATIVES

Indirect capital costs include:

- Engineering Costs
- Project management and administration
- Legal, license, and permits

These items are a percentage of direct costs. The percentages for these items remained the same as those in the cost estimate for Alameda Facility/Alameda Annex. The magnitude of these costs has increased in Alternatives 3 and 4 based on a increase in the areal coverage of the project.

TOTAL COSTS OF ALTERNATIVES FOR THE FORMER SUBTIDAL AREA AND MARSH CRUST AT ALAMEDA FACILITY/ALAMEDA ANNEX AND ALAMEDA POINT

The total cost of each alternative includes the sum of the direct capital and indirect capital cost plus a 5 percent contingency allowance on the sum. The total costs for alternative 2 for the combined area of Alameda Facility/Alameda Annex and Alameda Point is double compared to the cost of just for Alameda

Facility/Alameda Annex. The total costs for all alternatives are shown in Tables A-14 and A-15. The costs for Alternative 3 and 4 increased substantially by including the Alameda Point area. Table A-15 shows how the new total costs for these alternatives were calculated by extrapolating the Alameda Facility/Alameda Annex costs over the entire 727 acres.

TABLE A-1

ALTERNATIVE 2 - INSTITUTIONAL CONTROLS, MARSH CRUST
ALAMEDA FACILITY/ALAMEDA ANNEX

Task	Description	Unit	Unit Cost ($)			Quantity	Extended Cost ($) [1]	Task Total ($)
			Labor	Equipt.	Materials			
1	**Direct Costs**							
1.1	**Institutional Controls (IC)**							
1.1.1	Drafting IC (engineering judgment)	LS				1	10,000	**10,000**
1.1.2	5-year review (6 events), $5,000/event	LS				1	30,000	**30,000**
	Direct Capital Costs							**40,000**
2	**Indirect Cost**							
2.1	Project management and administration	**15%**					6,000	
2.1	Legal, license, and permit costs	**1%**					400	
	Indirect Capital Costs							**6,400**
	Capital Costs Subtotal							**46,400**
3	**Contingency Allowances**	**5%**						**2,320**
4	**Capital Costs Total**							**$48,720**

Notes:

LS Lump sum

1 Extended cost includes adjustment factors listed on Table A-9.

TABLE A-2

ALTERNATIVE 3 - EXCAVATION AND OFF-SITE DISPOSAL, MARSH CRUST
ALAMEDA FACILITY/ALAMEDA ANNEX

Task	Description	Unit	Unit Cost ($)			Quantity	Extended Cost ($) [1]	Task Total ($)
			Labor	Equipt.	Materials			
1	**Direct Capital Costs**							
1.1	**Sampling of Marsh Crust Direct Capital Costs (See Table A-5)**							**748,644**
1.2	**Demolition Direct Capital Costs (See Table A-6)**							**53,281,429**
1.3	**Excavation and Backfill Direct Capital Costs (See Table A-7)**							**48,567,219**
1.4	**Haul to Landfill**							
1.4.1	Soil from 15 to 16.5 feet bgs hauled 200 miles round trip to landfill (RACER 33.19.96.01)	cy	1.15	1.10	28.64	449,877	13,896,703	**13,896,703**
1.5	**Landfill Dump Fee**							
1.5.1	Dump charge (ECHOS 33 19 7265)	cy			304	449,877	136,762,629	**136,762,629**
1.6	**Import and Backfill Volume of Contaminated Soil**							
1.6.1	Import, backfill, and compact unclassified fill (RACER 33.03.98.01)	cy	1.31	1.44	4.78	449,877	3,387,574	**3,387,574**
							Direct Capital Total	**256,644,198**
2	**Indirect Capital Cost**							
2.1	Engineering costs	**10%**					25,664,420	
2.2	Project management and administration	**15%**					38,496,630	
2.3	Legal, license, and permit costs	**1%**					2,566,442	
							Indirect Capital Total	**66,727,491**
							Capital Subtotal	**323,371,689**
3	**Contingency Allowances**	**5%**						**16,168,584**
4	**Capital Costs Total**							**$339,540,274**

Notes:

bgs Below ground surface

cy Cubic yard

ECHOS Environmental Cost Handling Options and Solutions Unit Cost Book (R.S. Means Company and Delta Technologies Group, Inc. 1997)

RACER Remedial Action Cost Engineering and Requirements (Delta Technologies Group, Inc. 1997)

1 Extended cost includes adjustment factors listed on Table A-9.

TABLE A-3

ALTERNATIVE 4 - EXCAVATION AND ON-SITE THERMAL DESORPTION, MARSH CRUST ALAMEDA FACILITY/ALAMEDA ANNEX

Task	Description	Unit	Unit Cost ($)			Quantity	Extended Cost ($) [1]	Task Total ($)
			Labor	Equipt.	Materials			
1	**Direct Capital Costs**							
1.2	**Sampling of Marsh Crust Direct Capital Costs (See Table A-5)**							**748,644**
1.3	**Demolition Direct Capital Costs (See Table A-6)**							**53,281,429**
1.4	**Excavation and Backfill Direct Capital Costs (See Table A-7)**							**48,567,219**
1.5	**On-Site Thermal Desorption**							
1.5.1	Indirect fire thermal desorption all-inclusive for 449,577 cy (RACER 33.14.02.01)	LS	2,392,058	588,773	64,725,455	1	67,706,286	**67,706,286**
							Direct Capital Total	**170,303,578**
2	**Indirect Capital Cost**							
2.1	Engineering costs	**10%**					17,030,358	
2.2	Project management and administration	**15%**					25,545,537	
2.3	Legal, license, and permits	**1%**					1,703,036	
							Indirect Capital Total	**44,278,930**
							Capital Costs Subtotal	**214,582,508**
3	**Contingency Allowances**	**5%**						**10,729,125**
4	**Capital Costs Total**							**$225,311,634**

Notes:

cy Cubic yard

LS Lump sum

RACER Remedial Action Cost Engineering and Requirements (Delta Technologies Group, Inc. 1997)

1 Extended cost includes adjustment factors listed on Table A-9.

TABLE A-4

ALTERNATIVE 2 - INSTITUTIONAL CONTROLS AND GROUNDWATER MONITORING
ALAMEDA FACILITY/ALAMEDA ANNEX

Task	Description	Unit	Unit Cost ($)			Quantity	Extended Cost ($) [1]	Task Total ($)
			Labor	Equipt.	Materials			
1	**Direct Costs**							
1.1	**Institutional Controls (IC)**							
1.1.1	Drafting IC (engineering judgment)	LS				1	10,000	
1.1.2	5-year review (6 events), $5,000/event	LS				1	30,000	
1.1.3	Groundwater Monitoring (See Table A-5)	LS				1	285,828	
	Direct Cost Subtotal							**325,828**
2	**Indirect Costs**							
2.1	Project management and administration	**15%**					48,874	
2.1	Legal, license, and permit costs	**1%**					3,258	
	Indirect Cost Subtotal							**52,132**
	Capital Cost Subtotal							**377,960**
3	**Contingency Allowances**							
	Contingency Allowances	**5%**					18,898	
4	**Capital Costs Total**							**$396,859**

Notes:

LS Lump sum

1 Extended cost includes adjustment factors listed on Table A-9.

TABLE A-5

GROUNDWATER MONITORING
ALAMEDA FACILITY/ALAMEDA ANNEX

Task	Description	Unit	Unit Cost ($)			Quantity	Extended Cost ($) [1]	Task Total ($)
			Labor	Equipt.	Materials			
1	**Monitoring, Sampling, Testing, Alalysis (RACER 98)**							
1.1	**Field Sampling - Capital Costs**							
1.1.1	Field Technician, 264 HR	LS	7,456	0	0	1	7,456	
1.1.2	Mobilize Crew, 50 Miles, Per Person, 12 EA	LS	0	0	2,070	1	2,070	
1.1.3	Load Supplies/Equipment, 6	LS	1,757	1,791	0	1	3,548	
1.1.4	Security Pass/Protocol, 6	LS	293	298	0	1	591	
1.1.5	Well Development Equipment Rental, 4 WK	LS	218	2	1,751	1	1,970	
1.1.6	Furnish 55 gal drum for purge water, 3 EA	LS	0	0	148	1	148	
1.1.7	Water Quality Parameter Testing Device, 6 WK	LS	0	0	1,449	1	1,449	
1.1.8	Van or Pickup Rental, 18 Day	LS	0	0	621	1	621	
1.1.9	60 Quart Ice Chest, 12 EA	LS	0	0	616	1	616	
1.1.10	Disposable Materials Per Sample, 186 EA	LS	0	0	1,213	1	1,213	
1.1.11	Decontamination Materials Per Sample, 186 EA	LS	0	0	1,123	1	1,123	
	Subtotal							**20,805**
1.2	**Laboratory - Capital Costs**							
1.2.1	Total Dissolved Solids, 186 EA	LS	0	0	2,995	1	2,995	
1.2.2	Total Petroleum Hydrocarbons, 186 EA	LS	0	0	28,449	1	28,449	
1.2.3	Volatile Organic Analysis, 186 EA	LS	0	0	67,379	1	67,379	
1.2.4	Base Neutral & Acid Extractable Organics, 186 EA	LS	0	0	104,811	1	104,811	
1.2.5	TAL Metals, 186 EA	LS	0	0	61,389	1	61,389	
	Subtotal							**265,023**
	Total Direct Capital Costs							**285,828**

Assumptions:

1	Number of wells to be sampled	20
2	Sampling rounds including baseline monitoring	6
3	Total period of sampling, years	5
4	Parameters to be analyzed:	
	Total dissolved solids	
	Volatile organic compounds	
	Semi-volatile organic compounds	
	Total petroleum hydrocarbons	
	Metals	
5	Level IV CLP Analysis	

TABLE A-6

SAMPLING OF MARSH CRUST
ALAMEDA FACILITY/ALAMEDA ANNEX

Task	Description	Unit	Unit Cost ($)			Quantity	Extended Cost ($) [1]	Task Total ($)
			Labor	Equipt.	Materials			
1	**Direct Capital Costs**							
1.1	**Planning Documents**							
1.1.1	Planning and Sampling and Analysis Plan (RACER 05.06.01-.02)	LS	4,019		9	1	4,028	
1.1.2	Health and Safety Plan (RACER 05.06.03)	LS	1,752		9	1	1,761	
1.1.3	Investigation-Derived Waste Plan (RACER 05.06.04)	LS	2,243		9	1	2,252	
1.1.4	Data Validation and Reporting (RACER 05.08.01-.03)	LS	6,674		9	1	6,683	**14,724**
1.2	**Mobilization/Demobilization**							
1.2.1	Two-Person Sampling and Crew, Local (RACER 05.11.08)	LS			382	1	382	
1.2.2	Drill Rig and Crew (RACER 33.23.11.01)	LS	1,218	881		1	2,099	**2,481**
1.3	**Decontamination Facility (300 square feet)**							
1.3.1	Capital Costs (RACER 33.17.98.01)	LS	1,675	132	5,698	1	7,505	
1.3.2	Operation Costs for 6 Months (RACER 33.17.98.99)	LS	14,859	61	3,069	1	17,989	**25,494**
1.4	**Field Sampling and Analysis Costs**							
1.4.1	Field Set Up to Collect 700 Samples (with QC = 946 samples) and Subsurface Sampling with Split Spoon Sampler (RACER 05.07.01 and 05.11.06)	LS	146,122		39,721	1	185,843	
1.4.2	Drilling to 18 Feet bgs, 700 Samples (RACER 33.23.11.01)	LS	103,014	42,280	189,392	1	334,686	
1.4.3	Analytical Costs for PAH EPA SW 8310 (CostPro)	LS			196	946	185,416	**705,945**
					Total Direct Capital Costs			**$748,644**

TABLE A-6 (CONTINUED)

SAMPLING OF MARSH CRUST
ALAMEDA FACILITY/ALAMEDA ANNEX

Notes:

bgs	Below ground surface
CostPro	CostPro Closure and Post-Closure Estimating Software Users Manual (Tetra Tech EM Inc. 1997)
EPA	U.S. Environmental Protection Agency
LS	Lump sum
PAH	Polynuclear aromatic hydrocarbon
QC	Quality control
RACER	Remedial Action Cost Engineering and Requirements (Delta Technologies Group, Inc. 1997)
SW	Solid waste

1 Extended cost includes factors listed on Table A-9.

TABLE A-7

DEMOLITION
ALAMEDA FACILITY/ALAMEDA ANNEX

Task	Description	Unit	Unit Cost ($)			Quantity	Extended Cost ($) [1]	Task Total ($)
			Labor	Equipt.	Materials			
1	**Direct Capital Costs**							
1.1	**Demolish, Haul, and Dispose of Buildings (non-explosive)**							
1.1.1	Demolition, Single and Multi-level Wood (ECHOS 17 02 0108)	ft^2	0.07	0.07		4,642,276	649,919	
1.1.1.1	Haul, 50 Miles One-way (RACER 33.03.77 based on 100,000 ft^2)	100,000 ft^2	171,316	268,210		46.42	20,402,797	
1.1.1.2	Load and Dump Charge (ECHOS 17 02 0409) (0.0320 cy/cf - RACER 33.03.77)	cy	5.65	7.50		1,782,634	23,441,639	
								44,494,355
1.1.2	Demolition, Multi-level Steel (ECHOS 17 02 0101)	ft^2	0.04	0.03		1,118,621	78,303	
1.1.2.1	Haul, 50 Miles One-way (RACER 33.03.77 based on 100,000 ft^2)	100,000 ft^2	171,316	288,348		11.19	5,141,897	
1.1.2.2	Load and Dump Charge (ECHOS 17 02 0409) (0.0339 cy/cf - RACER 33.03.77)	cy	3.24	4.31		455,055	3,435,665	
								8,655,865
1.1.3	Demolition Single-level Masonry (ECHOS 17 02 0107)	ft^2	0.07	0.07		27,966	3,915	
1.1.3.1	Load and Haul, 50 Miles One-way (RACER 33.03.77 based on 28,000 ft^2)	28,000 ft^2	0.06	59,925		1	59,925	
1.1.3.2	Dump Charge (ECHOS 17 02 0409) (0.0275 cy/cf - RACER 33.03.77)	cy	3.13	4.17		9,229	67,369	
								131,209
							Total Direct Capital Costs	**$53,281,429**

Notes:

cf Cubic foot

cy Cubic yard

ECHOS Environmental Cost Handling Options and Solutions Unit Cost Book (R.S. Means Company and Delta Technologies Group, Inc. 1997)

ft^2 Square foot

RACER Remedial Action Cost Engineering and Requirements (Delta Technologies Group, Inc. 1997)

1 Extended cost includes factors listed on Table A-9.

TABLE A-8

EXCAVATE, HAUL, STOCKPILE, AND BACKFILL MARSH CRUST ALAMEDA FACILITY/ALAMEDA ANNEX

Task	Description	Unit	Unit Cost ($)				Quantity	Extended Cost ($)[2]	Task Total ($)
			Labor	Equipt.	Materials	All Inclusive[1]			
1	**Direct Capital Costs**								
1.1	**Site Security**								
1.1.1	Fencing (RACER 33.03.05.05)	LF	13.82	4.73	25.31		17,390	762,725	**762,725**
1.2	**Decontamination Facility (300 square ft)**								
1.2.1	Capital Costs (RACER 33.17.98.01)	LS	1,675	132	5,698		4	30,020	
1.2.2	Operation Costs for 6 Months (RACER 33.17.98.99)	LS	14,859	61	3,069		4	71,956	**101,976**
1.3	**Sheet Pile Around Site**								
1.3.1	Steel Sheeting Installation, Pull, and Salvage (ECHOS 17 03 0904)	ft^2	4.73	2.90	10.96		295,630	5,495,762	**5,495,762**
1.4	**Dewatering Excavation and Water Treatment**								
1.4.1	Pumping Water from Excavation to Package Plant (ECHOS)	MG				20,000	98	1,956,928	
1.4.2	Package Plant 0.8 Million Gallons per Day (RACER 33.03.68.01)	LS			2,137,951.20		1	2,137,951	**4,094,879**
1.5	**Excavation**	LS							
1.5.1	Top 5 ft of Dry, Clean Soil with Scraper (haul of 20% volume included) (RACER 33.03.98.01)	cy	0.20	0.46			1,153,531	761,330	
1.5.2	Dragline from 5 to 16.5 ft bgs Formerly Wet (Means 1997)	cy				1.39	2,653,121	3,687,838	

TABLE A-8 (CONTINUED)

EXCAVATE, HAUL, STOCKPILE, AND BACKFILL MARSH CRUST
ALAMEDA FACILITY/ALAMEDA ANNEX

Task	Description	Unit	Unit Cost ($)				Quantity	Extended Cost ($)[2]	Task Total ($)
			Labor	Equipt.	Materials	II Inclusive			
1.6	**Hauling to Stockpile**								
1.6.1	Top 6 to 15 ft of Clean Soil (assume 10% of volume hauled to stockpile area, the rest piled near excavation) Hauled 4,000 ft One-way to Stockpile Area (RACER 33.03.87)	cy	0.28	1.14			299,918	425,884	
1.6.2	15 to 16.5 bgs Hauled 4,000 ft One-way to Treatment Area Stockpile (RACER 33.03.87)	cy	0.28	1.14			449,877	638,825	
									1,064,709
1.7	**Stockpile Areas (2-ft earth berm, 275 ft square, 30 ft high)**								
1.7.1	Stockpile Areas for 0 to 5 ft Clean Soil (assume 20% of volume needs to be stockpiled at one time, dry soil no liquid handling)	Each					14	60,791	**828,799**
1.7.1.2	Grade 12G Dozer, 3 Passes (ECHOS 17 03 0102)	yd^2	0.20	0.26			10,503	4,832	
1.7.1.3	40 Mil PVC liner (ECHOS 33 08 0563)	ft^2	0.04		0.63		83,521	55,959	
1.7.2	Stockpile areas for Top 6 to 15 ft clean (assume 10% of volume, the rest stockpiled near excavation)	Each	0.00				14	1,765,836	**24,074,672**
1.7.2.1	Grade 12G Dozer, 3 Passes (ECHOS 17 03 0102)	yd^2	0.20	0.26			10,503	4,832	
1.7.2.2	40 Mil PVC Liner (ECHOS 33 08 0563)	ft^2	0.04		0.63		83,521	55,959	
1.7.2.3	Gravel, Placed in Two, 6-inch Lifts (ECHOS 17 03 0430)	cy	3.05	2.14	15.15		83,521	1,698,817	
1.7.2.4	Precast Drain (ECHOS 18 02 0203)	Each	1,224.06	46	1,844		2	6,228	

TABLE A-8 (CONTINUED)

EXCAVATE, HAUL, STOCKPILE, AND BACKFILL MARSH CRUST
ALAMEDA FACILITY/ALAMEDA ANNEX

Task	Description	Unit	Unit Cost ($)				Quantity	Extended Cost ($)[2]	Task Total ($)
			Labor	Equipt.	Materials	All Inclusive[1]			
1.7.3	Stockpile Area for Damp Soil 15 to 16.5 bgs (treatment area stockpiles) 20% Needs to be Stockpiled at Any One Time	Each	0.00				4	129,938	531,456
1.7.3.1	Grade 12G Dozer, 3 Passes (ECHOS 17 03 0102)	yd^2	0.20	0.26			10,503	4,832	
1.7.3.2	40 Mil PVC Liner (ECHOS 33 08 0563)	ft^2	0.04		0.63		83,521	55,959	
1.7.3.3	Gravel, Placed in Two, 6-inch Lifts (ECHOS 17 03 0430)	cy	3.05	2.14	15.15		3,093	62,919	
1.7.3.4	Precast Drain (ECHOS 18 02 0203)	Each	1,224.06	46	1,844		2	6,228	25,434,927
					Total Direct Capital Costs				**$ 48,567,219**

Notes:

bgs	Below ground surface
cy	Cubic yard
ECHOS	Environmental Cost Handling Options and Solutions Unit Cost Book (R.S. Means Company and Delta Technologies Group, Inc. 1997)
ft	Foot
ft^2	Square foot
LF	Linear foot
LS	Lump sum
MG	Million gallons
PVC	Polyvinyl chloride
RACER	Remedial Action Cost Engineering and Requirements (Delta Technologies Group, Inc. 1997)
yd^2	Cubic yard

1 Means includes loaded rates for labor, equipment, and materials.

2 Extended cost includes factors listed on Table A-9.

TABLE A-9

ADJUSTMENT FACTORS, MARSH CRUST
ALAMEDA FACILITY/ALAMEDA ANNEX

Note[1]	Description	Multiplier Factor		
		Labor	Equipt.	Materials
1	All work at Level D except construction of decontamination area at Level E			
2	Contractor Overhead and Profit Multiplier is equal to	1.55	1.1	1.1
3	Escalation from 1997 dollars to 1998 (ENR 1998)	1.006	1.006	1.006
4	Costs adjusted for location by factor of	1.18	1.18	1.18
Indirect Costs		**All Alternatives**		
Project management		10%		
Engineering		15%		
Permits		1%		
Contingency		5%		

Notes:

CostPro — CostPro Closure and Post Closure Estimating Software Users Manual, Version 3.0 (Tetra Tech EM Inc. 1997)

ECHOS — Environmental Cost Handling Options and Solutions Unit Cost Book (R.S. Means Company and Delta Technologies Group, Inc. 1997)

Means — Means Heavy Construction Cost Data (Means 1997)

RACER — Remedial Action Cost Engineering and Requirements (Delta Technologies Group, Inc. 1997)

1 — For RACER, ECHOS, and CostPro values, Notes 1 through 4 apply. For Means values, Notes 1, 3, and 4 apply.

TABLE A-10

ASSUMPTIONS FOR ESTIMATING SOIL VOLUMES
ALAMEDA FACILITY/ALAMEDA ANNEX

Item	Description	Quantity	
	Total acreage	143	
	Time to complete (years)	0.50	6 months
1	**Dry Soil - 0 to 5 ft bgs**		
	Soil will be dry and will be removed and hauled with 34-cy scrapers with D91 dozers (Means 1997a, ECHOS 33.03.98).		
	Depth (ft)	5	
	Volume to excavate (bcy)	**1,153,531**	
	Excavation rate (bcy/hour)	690	
	Scraper years	0.7	8 hours/day, 6 days/week, 51 weeks/year
	Number of scrapers	**2**	
2	**Damp Soil - 5 ft bgs to Bottom of Marsh Crust**		
	Damp soil will be removed by 4-cy-capacity dragline (Means 1997b, p. 355) with 95-ft boom.		
	Depth to top of marsh crust (ft)	15.0	
	Depth to bottom of marsh crust (ft)	16.5	
	Volume of damp, clean soil (bcy)	**2,307,062**	
	Volume of damp, dirty soil (bcy)	**346,059**	
	Total volume to excavate	**2,653,121**	
	Excavation rate (bcy/hour)	155	
	Dragline years	7.0	8 hours/day, 6 days/week, 51 weeks/year
	Number of draglines	**14**	
3	**Amount to be Hauled and Stockpiled**		
	Stockpile base diameter (ft)	275	Engineering judgment
	Stockpile height (ft)	30	Engineering judgment Formula for conical stockpile Volume (cubic ft) = 0.2318 X D^2 X H (D=diameter (ft), H=height (ft)) (Glover 1996).
	Volume per stockpile (cy)	**21,998**	
3a	Scraper loads from 0 to 5 ft bgs		
	Assume 20 percent of soil will be stockpiled at a time, other portions will be excavated or backfilled (cy).	**299,918**	Includes 30% swell factor
	Number of stockpiles	**14**	

TABLE A-10 (CONTINUED)

ASSUMPTIONS FOR ESTIMATING SOIL VOLUMES
ALAMEDA FACILITY/ALAMEDA ANNEX

Item	Description	Quantity	
3b	Damp soil from 5 ft bgs to top of marsh crust		
	Assume 10 percent of soil will be hauled and stockpiled, the rest will be placed in non-engineered stockpiles near the excavation (cy).	**299,918**	Includes 30% swell factor
	Number of stockpile areas	**14**	
3c	Damp soil to be treated (cy)		
	Assume 20 percent of soil will be stockpiled at a time, other portions will be excavated or backfilled (cy).	**89,975**	Includes 30% swell factor
	Number of stockpile areas	**4**	
4	**Thermal Desorption**		
	Volume of soil to treat (cy)	**449,877**	Includes 30% swell factor
	Soil density (ton/cy)	1.5	Engineering judgment
	Treatment rate (ton/hour)	155	ECHOS (Means 1997a)
	Thermal treatment years	0.6	24 hours/day, 6 days/week, 51 weeks/year
	Number of treatment units	**1**	

Notes:

bcy Bank cubic yard

bgs Below ground surface

cy Cubic yard

ECHOS *Environmental Cost Handling Options and Solutions Unit Cost Book*

ft Foot

TABLE A-11

BUILDING DEMOLITION ASSUMPTIONS
ALAMEDA FACILITY/ALAMEDA ANNEX

Building Material	Number of Stories [1]	Percent	Square Feet [2]	Cubic Feet [3]	Cubic Yards [3]
Wood	2	75	4,194,828	50,337,936	1,610,814
Wood	4	4	447,448	5,369,380	171,820
Steel	2	20	1,118,621	13,423,450	455,055
Brick	1	1	27,966	335,586	9,229
Total acreage of structures from GIS data and site visit					64.2

Notes:

GIS Global Information System
TtEMI Tetra Tech EM Inc.

1 Buildings have 12-foot stories.
2 Total acreage of structures X percent X number of stories X 43,560 $feet^2$ /acre.
3 See Table A-3 for conversion factors.

TABLE A-12

CONVERSION FACTORS
ALAMEDA FACILITY/ALAMEDA ANNEX

Initial Unit	Relation to Other Units	Comments
Acre-ft	1,613.33 cy	
Excavation working hours	4.08E-04 years	8 hours/day, 6 days/week, 51 weeks/year
Thermal working hours	1.36E-04 years	24 hours/day, 6 days/week, 51 weeks/year
bcy	1.3 cy	Swell factor
Acres	43,560 ft^2	
cf	0.032 cy	Demolition factor - wood (RACER)
cf	0.0339 cy	Demolition factor - steel (RACER)
cf	0.0275 cy	Demolition factor - masonry (RACER)

Notes:

bcy	Bank cubic yard
cf	Cubic foot
cy	Cubic yard
ft	Foot
ft^2	Square foot

Table A-13

Calculation of Excavation and Haul Costs for Combined Area of Alameda Annex and Alameda Point used in Alternatives 4 and 5

Task	Description	Alameda Annex Cost ($)	Alameda Annex Cost ($) Per Acre ft	Total Ac-ft Annex & Point	Multplier a	New Cost for Annex and Point ($)
1	**Direct Capital Costs**					
1.1	**Site Security**					
1.1.1	Fencing (RACER 33.03.05.05)	762,725	NA	NA	5.1	3,889,898
1.2	**Decontamination Facility (300 square ft)**					
1.2.1	Capital Costs (RACER 33.17.98.01)	30,020	NA	NA	5.1	153,102
1.2.2	Operation Costs for 6 Months (RACER 33.17.98.99)	71,956	NA	NA	5.1	366,976
1.3	**Sheet Pile Around Site**					
1.3.1	Steel Sheeting Installation, Pull, and Salvage (ECHOS 17 03 0904)	5,495,762	NA	NA	5.1	28,028,386
1.4	**Dewatering Excavation and Water Treatment**					
1.4.1	Pumping Water from Excavation to Package Plant (ECHOS)	1,956,928	6,506.78	1,293	NA	8,413,916
1.4.2	Package Plant 0.8 Million Gallons per Day (RACER 33.03.68.01)	2,137,951	NA	NA	1.0	2,137,951
1.5	**Excavation**					
1.5.1	Top 5 ft of Dry, Clean Soil with Scraper (haul of 20% volume included) (RACER 33.03.98.01)	761,330	NA	NA	5.1	3,882,783
1.5.2	Dragline from 5 ft bgs to bottom of marsh crusts Formerly Wet (Means 1997)	3,687,838	2,243	4,273	NA	9,581,203

TABLE A-13 (CONTINUED)

CALCLATION OF EXCAVATION AND HAUL COSTS FOR COMBINED AREA OF ALMEDA ANNEX AND ALMEDA POINT USED IN ALTERNATIVES 4 AND 5

Task	Description	Alameda Annex Cost ($)	Alameda Annex Cost ($) Per Acre-ft	Total Ac-ft Annex & Point	Multplier a	New Cost for Annex and Point ($)
1.6	**Hauling to Stockpile**					
1.6.1	5 ft to top of marsh crust of Clean Soil (assume 10% of volume hauled to stockpile area, the rest piled near excavation) Hauled 4,000 ft One-way to Stockpile Area (RACER 33.03.87)	425,884	298	3,182	NA	947,666
1.6.2	Marsh Crust layer Hauled 4,000 ft One-way to Treatment Area Stockpile (RACER 33.03.87)	638,825	NA	NA	5.1	3,258,008
1.7	**Stockpile Areas (2-ft earth berm, 275 ft square, 30 ft high)**					
1.7.1	Stockpile Areas for 0 to 5 ft Clean Soil (assume 20% of volume needs to be stockpiled at one time, dry soil no liquid handling)	828,799	NA	NA	5.1	4,226,875
1.7.2	Stockpile areas for 5 ft bgs to top of Marsh cust (clean soil) (assume 10% of volume, the rest stockpiled near excavation)	24,074,672	16,835	3,182	NA	53,570,354
1.7.3	Stockpile Area for Damp Marsh crust (treatment area stockpiles) 20% Needs to be Stockpiled at Any One Time	531,456	NA	NA	5.1	2,710,426
					Total	$121,167,542

a If depth of layer is the same for both sites, this multipier is equal to the area of both sites (727 acres) divided by the area of Alameda Annex (143 acres) or 5.1.

If depth of layer is not the same for both sites, this multiplier is not determined. Instead, first the cost per acre-ft of volume is calculated for Alameda annex. Next the total volume (acre-ft) is calculated for both sites based on the depth of the layer for each site. The total acre-ft is multipled by the cost per acre-ft for Alameda Annex to get the new total cost.

TABLE A-14

COST ESTIMATE FOR COMBINED AREA OF ALAMEDA ANNEX AND ALAMEDA POINT FOR ALTERNATIVES 1 AND 2

Number	Alternative	Alameda Facility/Alameda Annex/Cost	Alameda Facility/Alameda Annex And Alameda Point Cost	Rationale
1	No Action	$0	$0	Always zero, basis of comparison for other alternatives.
2	Institutional Controls	$48,720	$97,440	Institutional controls involve administrative and legal procedures that can be done for the same cost whether the site is 143 acres (Alameda Facility/Alameda Annex) or 584 acres (Alameda Point). It assumed that the institutional control will be initiated independently at each site at different times. The costs, therefore, for Alternative 2 for the combined Alameda Facility/Alameda Annex and Alameda Point area is two times the cost for Alameda Facility/Alameda Annex.

TABLE A-15

EXTRAPOLATED COST ESTIMATE FOR COMBINED AREA OF ALAMEDA ANNEX AND ALAMEDA POINT FOR ALTERNATIVES 4 AND 5

		Alt 4			Alt 5		
		Excav. & Off-Site Disposal			Excav. & On-Site Themal Desporption		
	Task	Alameda Annex Cost	Multiplier	Alameda Annex & Alameda Point Cost	Alameda Annex Cost	Multiplier	Alameda Annex & Alameda Point Cost
Direct Costs							
	1.1	$748,644	5.1	$3,818,084	$748,644	5.1	$3,818,084
	1.2	$53,281,429	5.1	$271,735,288	$53,281,429	5.1	$271,735,288
	1.3	$48,567,219	NA	$121,167,542	$48,567,219	NA	$121,167,542
	1.4	$13,896,703	5.1	$70,873,185	$67,706,286	5.1	$345,302,059
	1.5	$136,762,629	5.1	$697,489,408			
	1.6	$3,387,574	5.1	$17,276,627			
			Total Direct Capital	$1,182,360,135			$742,022,973
Indirect Costs							
Engineering Costs (10%)			$118,236,013			$74,202,297	
Project managment and administration (15%)			$177,354,020			$111,303,446	
Legal, license, and permit costs (1%)			$11,823,601			$7,420,230	
			Total Indirect Capital	$307,413,635			$192,925,973
			Capital Total	$1,489,773,770			$934,948,946
Contingency Allowances (5%)				$ 74,488,688			$ 46,747,447
			Capital Costs Total	**$ 1,564,262,458**			**$ 981,696,393**